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METHODS OF PROGRAMED INSTRUCTION RELATED TO STUDENT CHARACTERISTICS.

BY- WOODRUFF, A. BOND AND OTHERS
NORTHERN ILLINOIS UNIV., DE KALB

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THIS STUDY INVOLVED 74 EIGHTH-GRADE STUDENTS AND THEIR YEAR-LONG WORK ON A PROGRAMED COURSE IN GENERAL SCIENCE. THE SUBJECTS WERE DIVIDED INTO FOUR TREATMENT GROUPS VARIED AS TO IN- OR OUT-OF-CLASS USE OF THE PROGRAM. TWO MEASURES WERE TAKEN--AN ACHIEVEMENT MEASURE OVER THE SUBJECT-MATTER CONTENT OF THE PROGRAMED COURSE, AND A PERFORMANCE MEASURE (NUMBER OF CORRECT FRAME-TO-FRAME RESPONSES). THESE MEASURES WERE RELATED TO METHOD OF PROGRAM USE (TREATMENT) AND INDIVIDUAL LEARNER CHARACTERISTICS. THE FINDINGS OF THIS STUDY HAVE IMPLICATIONS FOR SCHOOL PRACTICE RELATIVE TO THE UTILIZATION OF PROGRAMED INSTRUCTION AND LEARNING PRINCIPLES AS THEY HAVE BEEN APPLIED TO THE CHARACTERISTICS OF PROGRAMED INSTRUCTION. (LP)

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METHODS OF PROGRAMED INSTRUCTION RELATED TO STUDENT CHARACTERISTICS

Cooperative Research Project No. 2284

Arnold Bond Woodruff
Shinkichi Shimabukuro
and
Sherman H. Frey

Northern Illinois University
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Introduction

One of the most neglected areas in programed instruction research is that of application and implementation in actual school settings. The research has been largely preoccupied with issues regarding the properties of programs which contribute most to learning. Thus, of the 190 or so research reports examined in his most recent survey of programed instruction, Schramm (1964) makes no citation of studies attempting to identify the conditions under which programs may be used most effectively. At least eighty per cent of the research of the past three years have been concerned with presentation and response mode variables. The remaining studies have been on a variety of issues, particularly comparisons between programed and "conventional" instruction, and the effectiveness of programmed instruction among various types of learner groups.

The need for such studies is not denied. Indeed, much research is still needed to tease out the critical variables of programed instruction. However, the intelligent and early application of programed instruction is predicated on the concurrent development of knowledge regarding the best ways of using available programs. It is unfortunate that reliable research studies on methods of using programs in the classroom are few and can be found mainly among the more recent studies.

Problem

This study was concerned with (1) the effects of four methods of implementing programed instruction, and (2) the effects of certain learner characteristics on programed instruction. The effects were

measured along two dimensions: (1) subject matter achievement over program content, and (2) performance on the program itself. The latter was operationally defined as the learner's frame to frame responses.

The four methods studies involved combinations of (a) in-class or out-of-class work on programs, and (b) teacher or student regulated scheduling of discussions and tests.

The individual learner characteristics will be discussed more fully later, but included the intelligence quotient, creativity measures, the reading ability level, and the past school achievements of the individuals involved.

Objectives

The objectives of the problem were stated in six sub-problems. It was hoped that an answer to four of these would result from this research and that the data gathered would give a basis for finding answers to the other two. The sub-problems were as follows:

1. In terms of subject matter achievement, which method brings about the most learning?
2. Is subject matter achievement through programed instruction affected by individual learner characteristics?
3. Is performance on the programed instruction affected by the method of utilization employed?
4. Is performance on the programed instruction affected by individual differences in learner characteristics?

In formulating this study certain assumptions were drawn from current knowledge about programed instruction. The first of these was that programed instruction is feasible and effective. More than adequate

demonstrations that people do learn from programed materials have been made in numerous studies. Moreover, research results indicate that learning accomplished through programed instruction is at least as effective as "conventional" methods of instruction (Stolurow, 1961).

A second assumption was that commercial programs will be used extensively in the public schools. The production of teaching materials and equipment of all types by private industry is a firmly established tradition, and there is every reason to believe that this tradition will continue. In fact, numerous enterprises are already deeply involved in the programed learning and teaching machines industry (Finn and Perrin, 1962). Also, there are time and experience factors which make programs developed by classroom teachers rather impractible. It seems reasonable to assume that, when the widespread use of programed instruction in the schools does materialize, it will mainly involve the use of commercially prepared programs (Schramm, 1964).

A third assumption made was that, at least into the near future, linear programs will be used extensively in the public schools. The assumption was made because programs currently being used and currently available for use in the schools and colleges are predominately linear (Center of Programed Instruction, 1963). Additionally, the great majority of the studies that have been conducted in the schools have utilized linear programs (Schramm, 1964).

A fourth assumption was that, initially, schools will utilize programed instruction working within the already established curriculum patterns, e.g.- in one or two courses, or units within courses. It is recognized that this may not result in the maximum realization of the

values of programed instruction. Nevertheless, an alternative to this approach is not a realistic possibility for some time. Programs covering the entire content of all subject areas are not available; also, most of the programs presently being published are of unit rather than course length (Hanson, 1963).

The research on methods of implementation. There are only a few studies directly concerned with the two basic variables in the four methods of program use investigated in this study, i.e. (a) in and out-of-class use, and (b) student and teacher scheduling of discussions and tests.

With respect to the former, there was a brief reference to a study (Klaus and Deterline, 1961) in which students were found to prefer using programs in the classroom with their teacher rather than working on programs at home. In a more recent study, Barty and Darby (1965) compared the achievement in intermediate algebra of "supervised" and "non-supervised" groups. The "supervised" group worked on programs in class under the supervision of a student monitor. The "non-supervised" group was issued programs and instructed to complete them on their own and to return them at the end of the term (summer session, 1962). The non-supervised group scored significantly lower than the supervised group in a teacher constructed achievement test. The two groups, however did not differ significantly on the Blyth Two-Year Algebra Test (BAT).

A study by Ferster and Sapon (1958) was the only study found which directly investigated the effect of student set schedule of program use. They found that the rate of completions of programs was quite low when

students are permitted to set their own schedules.

Student and teacher scheduling, however, in a general sense affects the pacing of the programed instruction. There was self-pacing when the student determined when he would take unit tests and engage in discussions with the teacher. In the sense that the teacher asked for the completion of units by specified dates so that group tests and discussions could be held, teacher scheduling was group-paced instruction. However, within the alloted time for the completion of a given program, the learners were permitted to work at their own rates. The pacing here, then, involved the pacing of units in the programed course utilized in this study.

Previous studies have regarded pacing as the control of the rate at which individual frames were presented. Most significant of these is a series of studies reported by Carpenter, Greenhill, et al, (1963). Self-pacing instruction in algebra and English grammar with teaching machines and programed texts were compared with group-paced instructions via filmstrips and closed-circuit television. No differences in achievement was observed between the groups. Studies in which pacing was set by pairs of students working together likewise showed no significant differences.

Frye (1963) compared the effect of group-paced and self-paced programed instruction among homogeneously and heterogeneously composed groups. The groups were compared in terms of the total time it took each subject in each group to obtain a perfect score on a post-test. The subject matter was the quadratic formula. It was found that no significant difference in total completion time results in group-paced

programed instruction when the group is homogeneously composed. There is, however, a significant increase in total completion time for group-paced instruction when the group is heterogeneously composed.

Briggs (1961) reported no significant differences between self- and group-pacing in programed instruction, but felt that variable pacing--slow at first and faster later in the program--might increase the efficiency of programed instruction.

Carpenter, Greenhill, et al (1963) reported that groups were paced at 20 per cent below and 10 per cent above the average rate for a self-pacing group with no significant differences in achievement. Silverman and Alter (1961) also reported no significant differences in learning between self-pacing and group-pacing at ample time and excessive time. However, it was noted that the group given excessive time indicated boredom.

Two studies reporting the effects of integrating teacher and programed instruction were found in the recent literature. Glaser, Reynolds, and Fullick (1963) compared various ways of combining programed and teacher instruction, teacher instruction followed by program, programed instruction followed by teacher explanations, and programed instruction alone, and found no significant differences. They also found that review and enrichment provisions did not increase learning from programs.

Goldbeck, et al (1962) evaluated various combinations of constructed answer and multiple choice programs with introductory and/or follow-up discussions by the teacher. It was found that combinations of teacher and programs were more effective than programs or teacher alone. The final phrase of this study indicated that "...programming,

combined with standard teaching procedures, substantially and significantly increased the amount of learning compared with the standard teaching procedure (with no programs)...."

The methods being considered in the present study have integrated the teacher with the programed instruction insofar as he was available to answer questions regarding any part of the programed course. He also provided enrichment and supplementary materials, but these were not really integrated with the programed instruction in that the particular topics selected were not directly covered by the program and no attempt was made to relate these additional materials with the program.

Bivens, Campbell and Terry (1963) compared two methods of implementing programed instruction among low-ability students. The first group used the linear form in which they were required to work through a mathematics program in sequence, reading all material, and answering all questions. The second group used the self-directed form in which each student worked through a program altering sequences, skipping sections, answering or not answering questions as he chose. In addition, both groups were given an outline of key concepts with indexed references to other material. The linear form group was required to use the outline after completing the program. The self-directed group was permitted to use the outline as they chose. No significant differences were noted between the groups, both on post tests and retention tests. Campbell and Bivens (1963) also studied the effects of self-directed programed instruction. They also found no significant difference in achievement between the linear form and the self-directed form, but

reported that regular instruction with no program resulted in significantly more learning, although it took more time. The students showed a decided preference for the self-directed form.

The methods under consideration in the present study utilized only the linear form. However, the two groups who worked on programs out-of-class spent their in-class time with supplementary and enrichment materials, including teacher led discussions and explanations of topics not covered by the programed course used. To some extent, these groups used the additional materials provided at their discretion. The research reviewed above would indicate that this measure of self-direction would not affect achievement on the content of the program.

The research on individual differences. Conflicting evidence exists in the literature concerning the relationship of student ability to achievement under the conditions of programed instruction. However, it is important to note in this respect that the investigations into this relationship have, for the most part, been conducted either within limited time spans (e.g. days or weeks) or over limited segments of subject matter (e.g. units). These approaches have contributed to the inconclusiveness of the results. The majority of these studies have focused on the influence of mental ability and prior achievement as predictors of achievement by means of programed learning. A somewhat lesser number have concerned themselves with the problem of reading and very few have addressed themselves to the task of investigating the relationship of creativity to programed learning.

Feldhusen and Eigen (1963) studied the interrelationships among various variables in programed instruction using linear programs on

sets, relations, and functions with high school students. They found that the variance in learning which may be attributed to IQ was less essential than that which could be attributed to general achievement level. IQ per se was not found to be the fundamental learner variable in programed instruction; nor, was the variance attributable to reading ability essential in accounting for learning in programed instruction. Porter (1959) and Keislar (1959) studied children within the normal ranges of ability in the schoolroom and found a slight negative correlation between IQ and effectiveness of programed learning. They suggested that the higher the mental ability of the student, the less effective programed instruction is as a method of instruction. Studies by Detambel and Stolurow (1956), Ferster and Sapon (1958), Gagné (1962), Coulson (1962), Hough and Revsin (1963), and Williams and Levy (1964), all report no significant correlations between aptitude and achievement in programed learning when gain score is used. Additionally, Meyer's study (1960) correlating reading level and difference scores revealed little, if any, relationship between aptitude and gain. As a result of his investigation into the differences in test scores between students using programed materials and those not using them, Brown (1962) suggests that homogeniety of performance among students of varying abilities can be reached through the use of programed learning materials. He is of the opinion, however, that this possibility should be checked in studies which involve the continuous use of these materials over an extended period of time.

Other investigations have revealed a positive relationship between student abilities and achievement in programed learning. Lambert, Mil-

ler, and Wiley (1962) reported as a result of their investigations that intelligence is the most significant factor associated with immediate acquisition in programed learning. Hatch and Flint (1962) in evaluating student performance variables found that academic intelligence predicted achievement for programed instruction about as well as it predicted it for conventional teaching. In a study involving mental retardates using a teaching machine Ordahl and Ordahl (1915) found a generally positive relationship between mental ability and rate of gain in achievement. Silberman (1962) in studying the rote versus the conceptual form in programing for high school students of different achievement groups discovered that on both forms of program the high achievement group did better than the medium achievement group, which did better than the low achievement group, when aptitude level and pre-test scores were controlled. Beane's investigation (1962) into the differences in achievement between high and low ability students following programed learning in geometry revealed that high ability students did significantly better than did low ability students. Jordy (1964) also showed that ability directly affects achievement in plane geometry using programed instruction. Wolfe (1963) used programed instructional materials to investigate the effects of expository instruction in mathematics on students accustomed to discovery methods. One of his findings was that high and low achievers in mathematics demonstrated the same relative level of achievement, using programed materials , as they had previously under regular instruction. Doty and Doty (1964) also found that prior achievement (GPA) was significantly correlated with achievement on programed instruction by college sophomores. Smith (1962) in attempting to identify some of the variance

which mental abilities contribute to performance in arithmetic at the fifth grade level using conventional and programed instruction found that positive correlations did not result from different instructional methods when the same ability was correlated with post-test learning scores. Further evidence of a positive relationship between aptitude and achievement in programed learning may be seen in a study reported by Schramm (1964) which reveals that students in the lowest IQ range made the smallest gain in achievement in a program in English grammar and usage. Reed and Hyman (1962) report similar results in an experiment involving the use of an English program in which the highest ability group gained the most and the lowest ability group, which had the most to learn, gained the least.

Studies reporting the relationship of creativity to performance in programed learning are virtually nil in the literature. The possibility that programed instruction can be effective in developing creativity is suggested by the investigation by Bass (1962) into the relationship of originality and performance on problem solving tasks. However, Doty and Doty (1964) secured modest negative correlation between creativity test scores and programed instruction achievement and suggests that this finding offers some indirect support to the criticism that programed methods restrict originality of thinking.

In most of the studies, the measure of effectiveness is the performance on a post-test as it is compared to a pre-test. Certainly, this is a good index of the learning product. However, it seems that a consideration of the frame-by-frame responses as they are related to individual learner characteristics could give valuable information

about the learning process involved in attaining the product.

Several investigations into error rate in programed learning have revealed significant correlations with achievement and intelligence. Hatch and Flint (1962) found that individual error rates, criterion performance, and intelligence were significantly intercorrelated. Schramm (1964) reported that the Denner experiment with programed learning in English revealed that the error rate for the slower classes was more than three times that of the acclerated students.

Three studies were conducted by Woodruff, Faltz and Wagner (1965) investigating the problem, "Does programed learning meet the individual differences among the students that are found in the normal classroom?" In two of these studies only one independent variable was manipulated, while the third was a correlational study. The duration of the learning periods was from four to six weeks.

In the first study, the relationship between "ability to learn" and performance on programed learning was considered. Thirty, ninth grade students enrolled in general science were divided into three groups designated as Fast, Average, and Slow learners. The criteria for each group is given below and a pupil had to meet all phases before he could be assigned to a group.

1. Fast Learners.

   I.Q.--120 and above

   Grade Average (7th and 8th grades)--B or above

   Science Grade (" " " ")--B or above

2. Average Learners

   I.Q.--95-105

   Grade Average (7th and 8th grades)--C

Science Grade (7th and 8th grades)--C

3. Slow Learners

I.Q.--90 or below

Grade Average (7th and 8th grades)--Below C

Science Grade (" " " ")--Below C

The subjects worked for 30 minutes each day studying a course in basic electricity, using a machine which required that the student write his answers on the program. The student progressed at his own rate and one week after he finished his program, he was given a retention test. The results were as follows:

1. The groups completed their programs in the order of their "learning ability."
2. In the retention test there was a high positive relationship between "ability to learn" and retention scores, although this was not perfect.
3. Correctness of Responses. (800 frames)
   a. Average number correct

      F. L. 648

      A. L. 549

      S. L. 410

      (This difference is significant at a probability level higher than .01.)
   b. There was no overlap of the performances of the groups when they are plotted in blocks of 50 frames on a graph.
   c. The Slow Learner left seven times as many blanks as the Fast Learners.

In the second study the problem of the relationship of the learner's level of reading ability and his responses on a program was considered. Fourteen pairs of children were matched on the basis of school grade and I.Q. Each pair was either in the fourth or fifth grade and no pair was separated by more than four I.Q. points, which is well within the error term for the test used. Those in the high reading group had to have a reading level at least one grade above their school grade, i.e., 5.0 for the fourth graders and 6.0 for the fifth graders. The low reading group had to have a reading level below their school grade; i.e., no higher than 3.9 for the fourth graders and no higher than 4.9 for the fifth graders.

The children worked for 30 minutes each school day on a commercially available spelling program. The program was presented one frame at a time to which the learners had to give written responses. The learners proceeded through the material until they finished 999 frames; this took from 8 to 12 learning sessions.

The measure considered was the number of correct responses made by the learners as they went through the program. First, in a comparison of the matched pairs, they found that in every pair, but one, the person in the high reading level group did better, with the differences being from 24 to 719 correct responses. In the latter case, they are sure that something is quite wrong, but the next highest difference was 485 and the next 325. In the one case where the student from the lower reading group did better the difference was 59 points. The average number of correct responses made by the high reading level group was 927 out of 999 frames, which is well within the 10 per cent

error limit that has been set down as the criterion of a good program. The average number of correct responses made by the low reading ability group was 718.57, which gives a difference between the groups of 209. The null hypothesis was rejected at a significance higher than the .01 level.

The third study was concerned with possible differences in performance that could be related to personality measures. The Ss were 26, 9th grade students enrolled in a general science course. The program was a non-commercial, "Introduction to Biology," containing a sequence of 208 frames. The Ss were given the Edwards Personal Preference Schedule (EPPS), the Gordon Personality Inventory (GPI), and the James Internal-External Scale (JIES).

Of the EPPS measures, only the need to achieve had a significant relationship to the S's performance ($r=.53$; $p<.01$). All five measures of the GPI proved to be significantly related to the S's performance. The coefficients of correlation were: cautiousness, .51; original thinking, .74; personal relations, .81; and vigor, .81. The correlation with the total score was .75. No significant relationship was found with the JIES.

All of these results indicate that there are functional relationships between certain learner characteristics and the performance of the learner on a programed learning sequence. However, since each of these studies involved a short program--thus, a short length of time--more extensive study is needed to find out what some of these relationships might be.

In the present study further investigation of this type was made.

PROCEDURES

Subjects

The Ss for this study were 80 eighth grade students of the public schools in Sandwich, Illinois who were enrolled in the year-long general science course. Of these, one S moved from the community, four others had to be changed in their registration for one reason or another, and we were unable to get the learner characteristics for one because of late registration, so, the final N for the study was 74.

Treatments

The Ss were divided into four classes which met during succesive periods in the afternoon during the entire academic year. The Ss were assigned to their respective classes by the administrative personnel of the school, with no attempt being made to match the Ss on pertinent learner variables, since the size of the available group and the mechanics of over-all scheduling made this impracticable. However, an examination of the learner characteristics measured in this study and the pre-test performance of the groups indicated no significant differences among them.

It should also be noted at this point that the experiment was incorporated into the on-going activities of the school; that is, its conditions did not take precedence over, nor, did they obviate the usual curricular and extra-curricular activities of the participating students. For, example, since a science fair was a usual annual activity in the school, the students were allowed to participate in it. Also, no student was prevented by virtue of being in the experiment from participating in the normal extra-curricular activities of the school (i.e., music, athletics, etc.)

Class Methods of Utilization: The methods of utilizing the programed instruction was varied along two dimensions: (1) in-class or out-of-class use of the programs; and (2) teacher or student regulated scheduling of rate of progress through the programs, discussions, and tests.

The treatments of the four groups differed in the following ways:

Group I (N = 15): The programed material was used during the regularly scheduled class period. The individual student progressed through the entire program at his own rate of speed. There were individual tests and conferences initiated by each of the students when he completed a unit of the program. However, each student was expected to meet a minimun time schedule, thereby discouraging any student from malingering unduly in his work. On the basis of unit test performance, the teacher had individual (or group) conferences covering the areas in which the student performed poorly. These conferences were scheduled on the basis of student need. If a student completed his program before the end of the semester he was provided with supplementary work. Homework was given by the teacher as desired and consisted of the supplementary work previously described, not the programed material.

Group II (N = 25): The programed material was used during the regularly scheduled class periods. The rate at which the student progressed through the material was regulated by the teacher to a great degree. This was done by having regularly scheduled times for discussing the material and for taking the unit examinations. Individual students who completed a given unit ahead of schedule of tests and discussions were given supplementary work. Supplementary materials and activities were also assigned as homework.

Group III (N = 16): The programed material was assigned as out-of-class work. Students progressed at their own individual rates; however, a minimum time schedule was established as in Group I. Unit examinations and conferences with the teacher during the regularly scheduled class periods were individually initiated by the students. Conferences were based on the needs of the students as indicated by test performances. Class time not occupied by examinations and conferences was taken up by supplementary work. Students who completed their programed material before the end of the semester were assigned further supplementary work.

Group IV (N = 18): The programed material was assigned as out-of-class work. Students progressed at their own rates, however, there were regularly scheduled class discussions and examinations initiated by the teacher as in Group II. When class time was not occupied by discussions and tests, students worked on supplementary materials and activities.

Programed materials: The programed instruction used used was TMI-Grolier's complete course, GENERAL SCIENCE, (TM-401). This course was divided into two approximately equal sections, with the students required to complete one section each semester of the school year. Appendix A lists the topics, units, and number of frames assigned to each of the sections. There were 3,583 frames for the first semester and 3,469 for the second.

Teacher: It was recognized that one of the critical variables in a study such as this would be the teacher. In this study one teacher handled all of the classes involved. The adminstrators of the school system, recognizing the complexities of his task, were able to relieve him of most of the other instructional duties for the school year. The teacher

had ten years experience teaching general science, was interested in trying new approaches in his teaching, and was regarded as a "very good" teacher by his supervisors. He had control of the classroom activities, working with the researchers in developing the instructional activities and supplementary materials.

Supplementary materials: It was recognized that supplementary materials would have to be provided for those students who finished their work on the programs ahead of schedule, and for those groups who worked on the programs outside of the classroom. The material provided consisted largely of films and filmstrips. In addition, lessons illustrated with 2 x 2 slides, individual study units, and resource units were prepared. (Appendix B gives a listing of titles and examples of materials especially prepared for the study.) Control over the influence that the supplementary materials might have on pupil achievement was exercised by selecting only materials which were not directly related to the content of the programed course.

It should be noted that the researchers do not necessarily advocate the instructional technique of not integrating supplementary materials with the basic text presentations. However, in this study such separation was required to allow an evaluation of the effects of the methods of utilization on the dependent variables.

Data Gathered

The measures used in this study fell into three categories. The first, "Basic Learner Characteristics," were independent variables along with the methods of utilizing the programs; whereas, the other two, "Achievement Measures" and "Performance Measures" were dependent variables.

These measures are operationally defined in the following paragraphs.

1. Basic learner characteristics. These measures were made at the beginning of the first semester. The purpose of these was to give additional data on the subjects to be used (1) for the adjustment of variables in the statistical evaluation, as far as achievement measures were concerned, if such an adjustment was necessary, and (2) for correlational studies, as far as achievement and performance measures of the learners were concerned. Included in these measured characteristics were the following:

a. Intelligence Quotient. This was determined by the Lorge-Thorndike Intelligence Tests, Level 4, Form A, Verbal and Non-Verbal Battery. This test had not been used as a part of the regular cummulative record data for the subjects.

b. Creativity. In the light of some of the work done in the past, it seemed possible that a measure of creativity might have a relationship to the performance of individuals on programed learning. Therefore, the Creative Thinking Tasks, Form DKC, developed by Torrence, was given to each of the students in the study. This test includes sub-tests "Circles," "Improvements," "Tin Cans," and "Consequences." These tests were scored at the University of Minnesota, Bureau of Educational Research.

c. Reading Ability Level. The Gates Reading Survey, Form M1, was used to determine this measure. Although there is a high correlation between the performance on a reading test and a group intelligence test, it was felt that this measure emphasizes a factor that has an important effect on performance in programed

learning. Woodruff, Faltz, and Wagner (1965) showed that a difference in reading level of one year or more brought about significant differences in the performances of fourth and fifth graders on a spelling program.

d. Over-all grade average, 6th & 7th grade. It was felt that this measure would give a good indication of the student's general achievement in his school work.

e. Science grade average, 6th & 7th grade. This gave an indication of the student's achievement in the subject matter area being used in this study. The sixth and seventh grades were chosen in these two measures since they are the first two grades in the school building in which the study was conducted.

It should be noted again that the researchers conducted the administration and scoring of the standardized instruments used for these measures.

2. Achievement measures. The measure utilized to determine the learning product, the objective of presenting the course, was a comprehensive test covering the programed material for the entire year. The same test was administered at three different stages of progress during the year: (a) at the beginning of the course before any of the subject matter was presented; (b) within a week following the student's completion of the first semester's work; and (c) within a week following the student's completion of the second semester's work. This test was objective in nature, consisting of 150 multiple choice items chosen from the items given by the publishers of the program. Seventy-five of the items applied to first semester materials and seventy-five to the second semester materials.

(See Appendix C for an example of the test given.)

In addition to this basic measure of achievement, examinations were given at the end of the prescribed units in the program. These tests were objective and short-answer in character. They were developed by the researchers in consultation with the classroom teacher and were utilized by the teacher in the end-of-year evaluation of students for grading purposes. However, these tests were not used in the formal evaluation of the study. (See Appendix D for a sample of a unit test.) The Ss were not informed of their scores on these tests.

3. Performance measures. In the study mentioned by Woodruff, et. al. (1965), it was found that there were differences in the kinds of frame-to-frame responses made by the students as they progressed through the program. Further, these differences in response can be related to certain learner characteristics. To further check this relationship, the frame-to-frame responses were scored as either "correct," "incorrect," or "blank."

Supervision of Study

With respect to the supervision of the experiment it should be noted that virtually no difficulty was encountered in achieving adherence to its design. This may be attributed to two factors: 1) the clear-cut differences of the treatment groups; and, 2) the complete understanding and willingness of the participating teacher in implementing the experimental phase of the study.

Careful attention to the orientation of interested groups in the school and the community paid rewarding dividends in cooperation from all concerned throughout the experimental phase of the study. This

cooperation was developed through a series of meetings prior to and during the initial phases of the experiment.

Shortly after receiving permission from the Sandwich (Illinois) Board of Education to conduct the study in their school system, a meeting of the administrators and the participating teacher was held to fully explain the nature of the experiment and its relationship to the operation of the school. In addition, the researchers were allocated time to explain the project at a general teacher's meeting before the opening of school. The parents of the participating students were met shortly after the opening of school for the same purpose and to answer questions on the effects of the experiment on their student's educational development. To each of these groups the request was made not to become overly concerned with the study, since this might affect the outcome. For instance, the teachers and administrators were asked not to visit the classes and the parents were asked not to inquire about progress or to put special emphasis on the work of this class. These requests were carried out as far as it could be determined by the researchers.

Participating students were oriented to their role in the experiment and to programed instruction as a method of teaching during the first class meeting of the school year. This was accomplished by verbal explanation to each treatment group on the specific way in which they would be using the programed material and by having each group work through a sample linear program in English.

The supervision of the project was conducted by the researchers through independent and joint visits to the school. In the initial stages of the experiment visits were made frequently to help the participating teacher acclimate himself to the various contingencies of the

experimental design. As the experiment progresses and as the teacher exhibited complete understanding, visits were made less frequently and primarily for the purpose of checking adherence to design requirements.

Attitude Measures

Because of cues picked up from the behavior of the Ss during the latter part of the first semester, it seemed advisable to attempt to determine their attitudes towards programed instruction at the end of each semester. The instrument developed covered attitudes involved in the S's reaction to programed instruction, *per se*; to characteristics of the programed text; to programed instruction compared to teacher explanation; and to programed texts compared to regular textbooks. It was constructed so that there were 25 pairs of items, one member of each pair was a positive attitude statement and the other member was a negative statement covering the same attitude. The statements were randomly listed, but the two members of one pair were never presented together. Although it was recognized that the instrument would have to be accepted on the bases of concept and face validity, a split-half technique, using the members of the pairs of items, gave a reliability coefficient of .97. The scores on this instrument proved beneficial in attempting to explain some of the results obtained. (See Appendix E.)

RESULTS

Appendix F presents a summary of all of the learner characteristic, achievement, and performance scores of all the Ss in terms of their group assignments. The learner characteristic scores used in this study are as follows:

Torrence CREATIVE THINKING TASKS, Form DKC

Circles Test

Fluency

Flexibility

Originality

Elaboration

Total

Improvements Test

Fluency

Flexibility

Originality

Elaboration

Total

Tin Cans Test

Fluency

Flexibility

Originality

Elaboration

Total

Consequences 1 — Language of animals understood by people.

Flexibility

Originality

Total

Consequences 2 — People become invisible at will.

Flexibility

Originality

Total

School grade averages 6th and 7th grades

All school grades

Science grades, only

Gates Reading Survey

Speed

Vocabulary

Comprehension

Total

Lorge-Thorndike Intelligence Tests

Verbal battery — raw scores

Verbal battery — I.Q.

Non-verbal battery — raw score

Non-verbal battery — I.Q.

The scores used in determining the achievement scores are as follows:

Score on criterion test at beginning of year. (Pre-test)

Score on criterion test at end of first semester. (Post-test 1)

Score on criterion test at end of second semester. (Post-test 2)

Post-test 1 minus Pre-test. (Achievement first semester.)

Post-test 2 minus Post-test 1. (Achievement second semester.)

Post-test 2 minus Pre-test. (Achievement for year.)

Achievement measures were determined for the materials covered in the programs for the first semester, second semester, and the year (first semester plus second semester).

The scores used for determining the performance were the number of correctly answered frames for each semester and the year. The measures of incorrect answers and blanks proved not to add any information for this problem.

Measures of Learner Characteristics

Table 1 gives a summary of the mean scores, standard deviations, and span of scores (lowest and highest scores) for each of the four groups and for the groups combined. An examination of the measures that are more usually related to predicting school success, i.e., average of past grades, intelligence indexes, and reading scores, shows that the groups are quite comparable, with the standard deviations indicating that there was wide overlapping of the groups. For the most part, the same observations can be made about the various Torrence creativity measures. In these measures there were a few instances, such as, "Consequences 1, Total," or, "Circles, Total," where the mean of one group was quite different from those of the other groups, but there was no pattern of one group being consistently superior or inferior to the other groups among these measures. Thus a general conclusion can be drawn that the four groups were quite similar along the dimensions of learner characteristics chosen for this study.

Achievement Measures

A summary of the groups' scores on the three administrations of the criterion test, and the resulting achievement measures are contained

Table 1

Scores of Groups on Learner Characteristics

Means (M), Standard Deviations (σ)

and Span of Scores (S)

Learner Characteristic		Group I N=15	Group II N=25	Group III N=16	Group IV N=18	Total N=74
Torrence, Circles	M	12.13	10.72	15.50	12.28	12.42
Fluency	σ	5.77	4.30	7.30	5.50	5.79
	S	5- 25	1- 21	5- 31	5- 25	1- 31
Torrence, Circles	M	9.60	8.00	10.13	10.11	9.30
Flexibility	σ	5.18	3.19	4.76	3.94	4.20
	S	3- 19	1- 17	5- 21	5- 17	1- 21
Torrence, Circles	M	7.40	7.12	9.31	7.17	7.66
Originality	σ	6.61	4.13	6.74	5.26	5.53
	S	0- 18	2- 16	3- 25	0- 15	0- 25
Torrence, Circles	M	20.47	29.56	36.50	12.83	25.15
Elaboration	σ	12.09	11.67	18.78	6.45	15.22
	S	6- 49	5- 54	16- 91	2- 27	2- 91
Torrence, Circles	M	49.60	55.40	71.06	42.39	54.45
Total	σ	22.34	18.74	34.13	18.08	25.06
	S	17- 82	9- 87	31-157	4- 80	4-157

Table 1 (continued)

Learner Characteristic		Group I	Group II	Group III	Group IV	Total
Torrence, Improvements	M	10.07	9.92	11.94	11.44	10.76
Fluency	σ	5.77	3.89	3.40	3.75	4.22
	S	3- 24	4- 19	8-18	5- 18	3- 24
Torrence, Improvements	M	4.40	4.40	5.44	4.50	4.65
Flexibility	σ	2.06	1.61	1.63	1.50	1.71
	S	2- 9	3- 8	3- 9	2- 7	2- 9
Torrence, Improvements	M	7.13	7.20	8.56	9.83	8.12
Originality	σ	5.34	4.13	4.72	5.71	4.95
	S	0- 21	0- 13	3- 19	2- 25	0- 25
Torrence, Improvements	M	.73	1.32	1.13	1.33	1.16
Elaboration	σ	1.22	2.90	1.41	2.14	2.14
	S	0- 4	0- 12	0- 4	0- 7	0- 12
Torrence, Improvements	M	22.33	22.84	27.06	27.11	24.69
Total	σ	12.58	9.33	8.47	10.36	10.18
	S	6- 54	7- 43	15- 40	12- 49	6- 54

Table 1 (continued)

Learner Characteristic		Group I	Group II	Group III	Group IV	Total
Torrence, Tin Cans	M	5.27	6.00	7.19	6.28	6.18
Fluency	σ	2.69	3.44	5.76	2.14	3.68
	S	2- 12	1- 13	1- 26	4- 11	1- 26
Torrence, Tin Cans	M	4.13	3.80	4.25	4.22	4.07
Flexibility	σ	1.77	1.96	2.84	1.06	1.95
	S	2- 8	1- 8	1- 12	3- 6	1- 12
Torrence, Tin Cans	M	4.53	3.88	5.00	5.94	4.76
Originality	σ	3.04	4.00	6.09	4.93	4.58
	S	0- 10	0- 12	0- 23	0- 19	0- 23
Torrence, Tin Cans	M	.67	.36	1.81	1.56	1.03
Elaboration	σ	.82	.64	2.17	2.46	1.73
	S	0- 2	0- 2	0- 7	0- 7	0- 7
Torrence, Tin Cans	M	14.33	14.04	17.63	18.00	15.84
Total	σ	6.77	8.40	11.55	7.07	8.63
	S	6- 31	2- 30	5- 63	8- 36	2- 63

Table 1 (continued)

Learner Characteristic		Group I	Group II	Group III	Group IV	Total
Torrence, Consequences 1	M	2.47	2.56	2.69	2.89	2.65
Flexibility	σ	1.46	.92	1.35	.83	1.11
	S	0- 5	1- 5	0- 6	1- 4	0- 6
Torrence, Consequences 1	M	3.13	2.64	3.13	3.11	2.96
Originality	σ	2.39	2.08	2.28	1.37	2.02
	S	0- 8	0- 8	0- 9	0- 5	0- 9
Torrence, Consequences 1	M	5.60	8.48	5.81	5.83	6.68
Total	σ	3.54	1.66	3.47	2.12	2.90
	S	0-12	0-12	0-15	1- 7	0-15
Torrence, Consequences 2	M	2.20	1.84	1.94	2.28	2.04
Flexibility	σ	1.01	.98	.68	1.32	1.02
	S	1- 4	1- 4	1- 3	1- 5	1- 5
Torrence, Consequences 2	M	1.80	1.80	1.88	2.11	1.89
Originality	σ	1.32	1.73	1.50	2.08	1.68
	S	0- 4	0- 6	0- 5	0- 8	0- 8
Torrence, Consequences 2	M	4.00	3.64	3.81	4.22	3.89
Total	σ	2.03	2.33	1.87	3.14	2.37
	S	1- 7	1-10	1- 8	1-12	1-12

Table 1 (continued)

Learner Characteristic		Group I	Group II	Group III	Group IV	Total
Grade Average, 6th & 7th	M	2.71	2.73	2.65	2.70	2.70
All subjects	σ	.80	.66	.93	.92	.80
(A = 4.0)	S	1.1-4.0	1.7-4.0	1.0-4.0	.8-4.0	.8-4.0
Grade Average, 6th & 7th	M	2.67	2.88	2.53	2.50	2.67
Science	σ	.77	.74	.96	1.02	.86
(A = 4.0)	S	1.5-4.0	1.5-4.0	1.0-4.0	.5-4.0	.5-4.0
Gates Reading Survey	M	19.87	18.76	20.81	21.28	20.04
Speed	σ	3.94	4.47	6.33	5.66	5.13
	S	13-26	11-28	12-30	10-30	10-30
Gates Reading Survey	M	37.53	36.36	33.31	37.33	36.18
Vocabulary	σ	7.26	8.76	11.63	11.31	9.77
	S	28-55	24-52	16-54	9-54	9-55
Gates Reading Survey	M	30.40	31.36	28.63	29.33	30.08
Comprehension	σ	5.26	4.91	8.51	9.39	7.06
	S	19-38	22-37	11-38	0-41	0-41
Gates Reading Survey	M	77.47	80.36	74.63	75.56	77.36
Total	σ	8.25	8.63	13.63	15.75	11.79
	S	64-93	60-94	45-98	27-94	27-98

Table 1 (continued)

Learner Characteristic		Group I	Group II	Group III	Group IV	Total
Lorge-Thorndike Verbal	M	47.80	50.96	49.81	51.67	50.24
Raw Score	σ	10.46	11.82	13.81	13.83	12.35
	S	32-68	32-74	23-71	25-80	23-80
Lorge-Thorndike Verbal	M	104.13	106.16	105.25	107.06	105.77
I. Q.	σ	10.13	12.45	14.97	14.96	13.03
	S	89-126	85-137	86-130	77-139	77-139
Lorge-Thorndike Nonverbal	M	46.53	50.72	46.50	50.39	48.88
Raw Score	σ	10.86	9.30	13.27	6.22	10.02
	S	23-64	19-64	25-63	36-65	19-65
Lorge-Thorndike Nonverbal	M	106.27	110.76	108.25	108.67	108.80
I. Q.	σ	12.91	11.93	16.09	9.29	12.44
	S	80-130	71-130	79-129	89-134	71-134

in Table 2. There are three rather clear observations that can be made from these data.

First, in both the criterion tests and achievement measures there were no marked differences among the means of the groups. As the size of the standard deviations indicate, the analyses of variance for these data all indicate that the within group variance is greater than the among group variance. Thus, no significance of differences were found.

Second, in comparing the achievement of the second semester with that of the first, there was a marked decline in the amounts achieved in all groups.

Third, each of the groups had at least one S who scored more poorly on one of the criterion tests than he did on the previous one. However, as groups, they all showed learning as defined by the performance of the Ss on the criterion test.

Performance Measures

The performance measures used were the number of correctly answered frames for each of the Ss. At the outset of the study it was thought that the "not-correct" frames would be divided into the "incorrect," which would be those where the wrong answer was written, and the "blank," where nothing was written. However, these measures alone gave no more information than just the "number correct," so only the one measure of performance was used.

Table 3 presents a summary of the means, standard deviations, and span of scores for the groups and for the total. As in the achievement measures, these means are so similar and the standard deviations are so large that the within group variance is larger than the variance

Table 2

Criterion Test and Achievement Measures

by Groups and Total

Means (M); Standard Deviations (σ); and Span of Scores (S)

Measure		Group I (N=15)	Group II (N=25)	Group III (N=16)	Group IV (N=18)	Total (N=74)
Criterion Test						
1. Pre-test	M	44.60	46.92	44.06	49.50	46.46
	σ	15.32	13.06	13.38	13.63	13.62
	S	19-66	31-82	24-68	24-79	19-82
2. Post-test 1	M	70.93	75.00	70.44	70.11	72.00
	σ	22.85	16.30	22.69	19.47	19.66
	S	37-121	48-107	27-101	36-106	27-121
3. Post-test 2	M	82.73	84.44	80.44	77.33	81.50
	σ	20.92	23.61	27.39	22.12	23.30
	S	53-129	39-124	31-115	36-125	31-129
Achievement						
1. First semester	M	25.40	28.12	26.25	21.17	25.48
	σ	14.97	12.32	16.43	10.81	13.56
	S	-1-+58	+6-+53	+3-+65	-1-+39	-1-+65
2. Second semester	M	11.86	9.08	6.94	6.39	8.51
	σ	7.94	11.69	11.84	10.68	10.77
	S	-7-+23	-20-+32	-23-+26	-26-+19	-26-+32
3. Year	M	37.26	37.20	33.19	27.56	33.99
	σ	14.30	19.59	18.30	16.05	17.62
	S	+14-+65	+6-+82	-3-+58	-2-+58	-3-+82

Table 3

Performance Scores--Number Correct Frames--by Groups

Means (M); Standard Deviations (σ); and Span of Scores (S)

No. of frames: 1st sem. = 3,583; 2nd sem. = 3,469; Total = 7,052

Performance Measure		Group I (N=15)	Group II (N=25)	Group III (N=16)	Total (N=18)
1. First Semester	M	3,333.67	3,225.48	3,215.56	3,250.22
	σ	136.64	272.30	388.34	334.50
	S	3,042-3,537	2,430-3,556	2,074-3,538	2,151-3,551
2. Second Semester	M	3,308.73	3,204.16	3,196.31	3,272.56
	σ	113.29	275.48	284.98	235.15
	S	3,086-3,453	2,233-3,466	2,617-3,443	2,692-3,454
3. Year	M	6,642.40	6,429.64	6,411.88	6,522.78
	σ	221.57	491.74	656.07	492.85
	S	6,226-6,954	5,319-7,006	4,691-6,978	4,970-6,979

attributable to the among groups variables.

In spite of this similarity between the achievement and performance data, Table 4 indicates that they are not highly correlated measures. Rather, the correlations between the first semester achievement and performance measures are r = .33; r = .12 for the second semester; and r = .35 for the year. Further, when the achievement is broken down into semester's materials, the r's remain about the same. These would indicate that the dependent variable measures are concerned with somewhat different behaviors.

Learner Characteristics Related to Achievement and Performance

Tables 5 through 14 give a summary of the coefficients of correlation between the various learner characteristics and the different achievement and performance measures for each group and for all of the Ss combined.

Creativity measures: When the various creativity measures were related to the achievement measures, there were few significant correlations. Only Group II had one involving the entire material of the criterion test (Improvements, fluency with second semester, r = .41; $p < .05$). The other significant correlations involved only material over a specific semester. These did not give any kind of a meaningful pattern. Further, there were no significant correlations when all of the groups were combined.

The picture for the correlations of these data with the performance measures is much the same. Group I had only one significant correlation, Group II had none, and Group IV had three. However, Group III had correlations (p = .05 to .01) involving all of the Consequences I scores

Table 4

Intercorrelations of the Achievement and Performance Measures (N = 74)

		2	3	4	5	6	7	8	9	10	11	12
1.	Achievement, 1st, 1st	.37	.88	-.34	.37	.07	.79	.54	.72	.33	.27	.33
2.	" , 1st, 2nd		.76	.03	-.08	-.02	.40	.64	.57	.21	.04	.15
3.	" , 1st, Tot			-.22	.22	.03	.74	.71	.79	.33	.22	.30
4.	Achievement, 2nd, 1st				.22	.72	.31	.19	.27	.04	-.02	.02
5.	" , 2nd, 2nd					.82	.51	.71	.67	.26	.19	.25
6.	" , 2nd, Tot						.54	.62	.64	.22	.12	.19
7.	Achievement, Yr , 1st							.67	.91	.36	.26	.34
8.	" , Yr , 2nd								.92	.35	.18	.30
9.	" , Yr , Tot									.37	.33	.35
10.	Performance, 1st										.67	.93
11.	" , 2nd											.89
12.	" , Tot											

Table 5

Correlations between Creativity Measures

and Achievement and Performance

Group I (N = 15)

Measure	Achievement									Performance		
Period	1st sem.			2nd sem.			Year					
Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Circles, Fluency	.23	.06	.19	-.26	.34	.11	.12	.32	.26	.41	.01	.26
" , Flexibility	.18	.00	.13	-.35	.48	.17	.01	.39	.23	.28	-.02	.16
" , Originality	.16	.15	.18	-.23	.56*	.31	.48	.34	-.03	.31	.16	.27
" , Elaboration	-.10	-.16	-.14	-.13	.51*	.34	-.20	.29	.04	.24	.28	.29
" , Total	.09	-.02	.06	-.29	.64+	.34	-.06	.50	.25	.39	.19	.34
Improvements, Fluency	.22	-.28	.03	-.34	.20	-.06	.006	-.06	.00	.10	-.31	-.10
" , Flexibility	.16	-.32	-.02	-.31	.46	.17	.01	.12	.08	-.02	-.49	-.26
" , Originality	.15	-.26	-.01	-.33	.06	-.17	-.02	-.15	-.10	.12	-.30	-.08
" , Elaboration	.42	.35	.44	.11	-.28	-.16	.57*	.05	.37	.09	.22	.17
" , Total	.23	-.26	.05	-.34	.17	-.09	.08	-.07	.01	.10	-.33	-.11
Tin Cans, Fluency	.04	-.12	-.02	-.26	.25	.03	-.11	.11	.00	.15	-.17	.00
" , Flexibility	.00	-.07	-.03	-.04	-.16	-.10	-.30	.22	-.02	-.23	.05	-.11
" , Originality	-.06	.06	-.02	-.08	-.10	-.14	-.12	-.04	-.09	-.13	-.17	-.17
" , Elaboration	.36	.13	.31	-.21	-.08	-.21	.31	.04	.21	.21	.55*	.41
" , Total	.01	-.04	-.01	-.19	.06	-.08	-.11	.01	-.06	.01	-.15	-.07
Consequences 1, Fluency	.37	.37	.41	-.31	.13	-.10	.26	.39	.38	.30	-.16	.11
" , Originality	.08	-.02	.05	-.13	-.02	-.07	.02	.00	.01	.11	-.17	-.02
" , Total	.21	.14	.20	-.21	.07	.09	.12	.16	.16	.20	-.18	.03
Consequences 2, Fluency	.28	.17	.26	-.71+	.27	-.24	-.10	.35	.14	.28	.21	.28
" , Originality	-.05	.43	-.21	-.35	.38	.08	-.27	-.03	-.18	.04	-.04	.01
" , Total	.11	-.19	-.01	-.58*	.38	-.07	-.22	.16	-.05	.16	.08	.14

* $r = .51$ ($p < .05$) + $r = .64$ ($p < .01$)

Table 6

Correlations between Ability Measures
and Achievement and Performance
Group I (N = 15)

Measure	Period	Achievement									Performance		
		1st sem.			2nd sem.			Year					
	Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Grade Average (all subjects)		.45	.39	.48	-.45	.39	.02	.27	.61*	.51	-.12	-.12	-.13
" " (science)		.31	.27	.33	-.45	.26	-.08	.10	.42	.29	.42	.30	-.11
Gates Reading, Speed		.50	.28	.47	-.50	.64+	.20	.30	.73+	.60*	.21	-.04	.11
" " , Vocabulary		.55*	.38	.54*	-.24	.41	.18	.51*	.62*	.66+	.30	.25	.31
" " , Comprehension		.62*	.65+	.70+	-.36	.22	-.05	.52*	.68+	.70+	.10	-.16	-.02
" " , Total		.70+	.60*	.74+	-.35	.21	-.06	.62*	.64+	.74+	.37	.07	.26
Intelligence, Verbal R.S.		.36	.39	.42	-.37	.49	.16	.21	.69+	.52*	-.04	-.09	-.07
" , Verbal I.Q.		.34	.40	.40	-.34	.46	.15	.20	.68+	.51*	-.04	-.08	-.06
" , Nonverbal R.S.		.54*	.35	.52*	-.28	.20	-.02	.47	.43	.53*	-.12	.07	-.04
" , Nonverbal I.Q.		.45	.29	.44	-.14	.23	.10	.46	.41	.51*	-.13	.07	-.04

* $r = .51$ ($p < .05$) + $r = .64$ ($p < .01$)

Table 7

Correlations between Creativity Measures

and Achievement and Performance

Group II (N = 25)

		Achievement									Performance		
	Period	1st sem.			2nd sem.			Year					
Measure	Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Circles, Fluency		-.10	-.41	-.30	-.12	-.11	-.14	-.16	-.32	-.27	.03	.23	.15
" , Flexibility		-.15	-.17	-.19	.04	-.10	-.05	-.10	-.17	-.15	-.01	-.22	.13
" , Originality		-.17	-.19	-.22	.24	.15	.21	.01	-.02	-.01	.12	.08	.11
" , Elaboration		-.10	-.39	-.29	-.07	.02	-.02	-.13	-.23	-.20	.10	.00	.06
" , Total		-.15	-.41*	-.33	-.01	.00	-.01	-.13	-.25	-.21	.09	.11	.11
Improvements, Fluency		.10	-.26	-.10	-.44*	-.28	-.41*	-.20	-.35	-.30	-.14	.03	-.06
" , Flexibility		.18	-.13	.03	-.06	-.02	-.04	.11	-.09	.00	.01	.16	.10
" , Originality		-.08	-.19	-.16	-.01	-.16	-.12	-.07	-.22	-.17	-.14	-.05	-.10
" , Elaboration		-.02	-.14	-.09	-.37	-.30	-.38	-.24	-.29	-.28	-.27	-.08	-.19
" , Total		.03	-.26	-.13	-.31	-.28	-.35	-.17	-.35	-.29	-.20	-.21	-.23
Tin Cans, Fluency		-.36	-.35	-.42*	-.10	-.19	-.18	-.36	-.34	-.37	-.20	-.21	-.23
" , Flexibility		-.20	.03	-.10	-.02	.13	.08	-.17	.11	-.01	-.03	-.33	-.20
" , Originality		-.26	-.07	-.19	.06	.14	.13	-.18	.06	-.05	.05	-.29	-.13
" , Elaboration		.09	-.10	.00	.10	.26	.22	.13	.11	.13	-.07	.09	.01
" , Total		-.31	-.17	-.29	-.01	.04	.02	-.26	-.08	-.17	-.07	-.29	-.20
Consequences 1, Fluency		.22	-.03	.11	-.04	.19	.11	.15	.11	.14	-.10	.25	.08
" , Originality		.07	-.01	.04	-.37	-.09	-.24	-.17	-.07	-.12	-.27	.03	-.13
" , Total		-.20	.06	-.08	.09	-.27	-.14	-.11	-.14	-.13	-.04	.09	.03
Consequences 2, Fluency		.03	.18	.12	.04	.15	.13	.05	.21	.15	.06	.21	.15
" , Originality		.26	.25	.30	-.26	.04	-.09	.05	.18	.13	-.13	.19	.04
" , Total		.21	..27	.28	-.17	.09	-.01	.06	.23	.17	-.07	.23	.09

* r = .40 ($p < .05$) + r = .50 ($p < .01$)

Table 8

Correlations between Ability Measures

and Achievement and Performance

Group II (N = 25)

Measure	Achievement									Performance		
Period	1st sem.			2nd sem.			Year					
Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Grade Average (all subjects)	.08	.11	.11	.45*	.51+	.62+	.35	.45*	.43*	.43*	.50+	.52+
" " (science)	.31	.30	.36	.41*	.66+	.66+	.51+	.63+	.62+	.63+	.62+	.48*
Gates Reading, Speed	-.09	-.01	-.07	-.05	.10	.05	-.11	.06	-.01	.45*	.52+	.54+
" " , Vocabulary	-.07	.12	.03	.15	.04	.10	.04	.10	.08	.35	.31	.37
" " , Comprehension	-.02	.12	.05	.49*	.39	.51+	.29	.34	.34	.39	.37	.42*
" " , Total	.10	.22	.19	.00	.22	.16	.08	.28	.21	.17	.06	.12
Intelligence, Verbal R.S.	-.08	.09	.00	.25	.27	.31	.10	.24	.19	.43*	.28	.39
" , Verbal I.Q.	.01	.17	.10	.17	.28	.28	.12	.29	.23	.44*	.29	.40*
" , Nonverbal R.S.	.21	.36	.34	.37	.58+	.58+	.41*	.61+	.56+	.63+	.34	.54+
" , Nonverbal I.Q.	.21	.37	.33	.29	.47*	.47*	.35	.54+	.49*	.57+	.35	.51+

* r = .40 ($p < .05$) + r = .50 ($p < .01$)

Table 9

Correlations between Creativity Measures

and Achievement and Performance

Group III (N = 16)

Measure	Achievement									Performance		
Period	1st sem.			2nd sem.			Year					
Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Circles, Fluency	-.49*	-.51*	-.53*	.58*	.19	.45	-.10	-.26	-.19	.00	-.07	-.03
" , Flexibility	-.14	-.13	-.14	.30	.25	.31	.08	.06	.07	.28	.28	.29
" , Originality	-.33	-.36	-.36	.43	.10	.32	-.03	-.21	-.12	.21	.11	.17
" , Elaboration	-.40	-.40	-.43	.64+	.25	.52*	.05	-.14	-.04	.12	.00	.08
" , Circles	-.40	-.40	-.42	.60*	.24	.49	.02	-.15	-.07	.18	.07	.14
Improvements, Fluency	.33	.10	.26	-.04	-.01	-.03	.33	.07	.21	.50*	.55*	.54*
" , Flexibility	.06	.12	.09	.16	-.09	.06	.19	.04	.12	.31	.23	.28
" , Originality	.44	.21	.37	-.23	-.08	-.18	.31	.10	.22	.39	.52*	.46
" , Elaboration	-.16	-.14	-.16	.33	.44	.42	.07	.17	.12	.01	.11	.05
" , Total	.37	.16	.30	-.06	.01	-.03	.35	.12	.25	.48	.57*	.53*
Tin Cans, Fluency	-.04	-.27	-.14	.10	-.20	-.03	.03	-.32	-.14	.14	.21	.18
" , Flexibility	-.04	-.35	-.17	.10	-.13	.00	.03	-.34	-.15	.03	.15	.08
" , Originality	-.06	-.29	-.16	.11	-.18	-.02	.02	-.32	-.15	.01	.19	.09
" , Elaboration	.15	.37	.25	.01	.22	.11	.17	.41	.30	.40	.32	.38
" , Total	-.04	-.28	-.14	.12	-.13	.01	.05	-.29	-.12	.12	.26	.18
Consequences 1, Fluency	.17	.40	.27	-.08	-.17	-.13	.12	.18	.16	.66+	.50*	.61+
" , Originality	.21	.31	.27	.12	.01	.08	.32	.23	.29	.70+	.64+	.70+
" , Total	.21	.36	.28	.05	-.06	.00	.26	.22	.25	.72+	.62+	.70+
Consequences 2, Fluency	.11	.24	.17	.23	.13	.21	.28	.26	.28	.49*	.34	.44
" , Originality	-.17	.20	-.03	.02	.17	.10	-.17	.25	.04	.13	-.06	.05
" , Total	-.10	.25	.04	.10	.19	.15	-.03	.30	.13	.28	.08	.20

* r = .49 ($p < .05$) + r = .62 ($p < .01$)

Table 10

Correlations between Ability Measures

and Achievement and Performance

Group III (N = 16)

Measure	Period	Achievement									Performance		
		1st sem.			2nd sem.			Year					
	Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Grade Average	(all subjects)	.48	.55*	.54*	-.03	.42	.18	.50*	.66+	.60*	.68+	.63+	.68+
" "	(science)	.57*	.56*	.60*	-.06	.43	.17	.57*	.68+	.65+	.62+	.60*	.63+
Gates Reading,	Speed	.47	.52*	.52*	.25	.61+	.45	.69+	.76+	.76+	.80+	.82+	.83+
" "	, Vocabulary	.54*	.69+	.64+	.04	.38	.21	.61*	.74+	.70+	.61*	.53*	.59*
" "	, Comprehension	.61*	.74+	.70+	.22	.48	.37	.82+	.84+	.87+	.78+	.67+	.75+
" "	, Total	.52*	.73+	.64+	.31	.58*	.48	.79+	.89+	.88+	.66+	.62+	.66+
Intelligence,	Verbal R.S.	.53*	.61*	.60*	-.02	.34	.15	.56*	.65+	.63+	.80+	.74+	.79+
"	, Verbal I.Q.	.50*	.62+	.58*	.06	.37	.22	.58*	.68+	.66+	.81+	.74+	.80+
"	, Nonverbal R.S.	.54*	.59*	.59*	-.18	.02	-.11	.44	.44	.46	.73+	.68+	.73+
"	, Nonverbal I.Q.	.50*	.65+	.59*	-.04	.15	.05*	.54*	.56*	.56*	.83+	.80+	.84+

* r = .49 ($p < .05$) + r = .62 ($p < .01$)

Table 11

Correlations between Creativity Measures

and Achievement and Performance

Group IV (N = 18)

Measure	Period	Achievement									Performance		
		1st sem.			2nd sem.			Year					
	Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Circles, Fluency		-.29	.25	-.15	.27	-.14	.12	-.08	.05	-.02	.04	-.08	-.01
" , Flexibility		-.12	.30	-.01	.40	-.17	.18	.15	.05	.11	.17	.03	.13
" , Originality		.09	.43	.23	.10	-.08	.07	.14	.21	.20	.35	.20	.33
" , Elaboration		-.11	.60+	.14	.33	-.23	.13	.11	.20	.18	.26	.12	.23
" , Total		-.13	.48*	.07	.31	-.19	.14	.09	.16	.14	.24	.08	.20
Improvements, Fluency		.21	.34	.24	-.11	.15	.15	.11	.35	.26	.11	-.36	-.10
" , Flexibility		.13	.34	.23	.28	.15	.32	.30	.36	.37	.39	-.05	.24
" , Originality		.31	.45	.33	-.09	.00	.10	.22	.30	.29	.18	-.56*	-.15
" , Elaboration		.36	.16	.38	-.51*	-.04	-.33	-.01	.07	.03	.17	.22	.22
" , Total		.34	.45	.38	-.15	.07	.09	.20	.36	.32	.23	-.40	-.04
Tin Cans, Fluency		.02	.12	-.04	-.12	.21	.21	-.07	.26	.11	.01	-.34	-.15
" , Flexibility		.09	.01	-.02	-.07	.11	.14	.04	.10	.08	-.17	-.63+	-.41
" , Originality		-.28	.33	-.15	-.04	-.33	-.12	-.27	-.06	-.18	-.32	-.45	-.44
" , Elaboration		.07	-.12	.01	-.01	.33	.20	.05	.20	.14	.16	.26	.23
" , Total		-.15	.22	-.12	-.08	-.03	.07	-.18	.12	-.03	-.19	-.43	-.34
Consequences, 1, Fluency		.17	.13	.12	.32	-.08	.18	.35	.02	.20	.26	-.02	.17
" , Originality		.17	.29	.21	.13	-.06	.10	.23	.14	.21	.23	-.18	.06
" , Total		.31	.37	.35	.20	.01	.20	.40	.25	.37	.52*	.04	.37
Consequences 2, Fluency		.24	.35	.29	-.14	.10	.07	.12	.31	.24	.21	-.35	-.02
" , Originality		.22	.42	.24	-.16	-.11	-.01	.09	.18	.16	.01	-.39	-.18
" , Total		.31	.44	.33	-.11	-.05	.04	.20	.25	.25	.18	-.35	-.04

* r = .47 ($p < .05$) + r = .59 ($p < .01$)

Table 12

Correlations between Ability Measures

and Achievement and Performance

Group IV (N = 18)

Measure	Period	Achievement									Performance		
		1st sem.			2nd sem.			Year					
	Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Grade Average (all subjects)		.42	.51*	.51*	.19	.25	.36	.48*	.55*	.58*	.81+	.35	.72+
" " (science)		.37	.58*	.51*	-.02	.09	.14	.31	.46	.44	.73+	.36	.67+
Gates Reading, (Speed		.38	.44	.43	-.12	.02	.03	.25	.31	.31	.59+	.24	.52*
" " , Vocabulary		.46	.62+	.59+	-.10	.05	.07	.34	.45	.45	.71+	.17	.57*
" " , Comprehension		.68+	.49*	.70+	-.05	.34	.28	.56*	.61+	.66+	.80+	.29	.68+
" " , Total		.62+	.53*	.67+	-.19	.23	.14	.42	.55*	.54*	.77+	.24	.63+
Intelligence, Verbal M.S.		.37	.61+	.50*	-.06	-.03	.06	.28	.38	.38	.71+	.56	.56*
" , Verbal I.Q.		.38	.69+	.55*	-.08	-.01	.07	.28	.45	.41	.68+	.19	.56*
" , Nonverbal M.S.		.30	.74+	.54*	.09	-.01	.13	.32	.48*	.45	.62+	.30	.57*
" , Nonverbal I.Q.		.32	.76+	.59+	.02	.03	.11	.29	.53*	.47*	.55*	.34	.53*

* $r = .47$ ($p < .05$) + $r = .59$ ($p < .01$)

Table 13

Correlations between Creativity Measures

and Achievement and Performance

All Groups (N = 74)

Measure	Period	Achievement									Performance		
		1st sem.			2nd sem.			Year					
	Material Covered	1 sem	2 sem	Yr	1 sem	2 sem	Yr	1 sem	2 sem	Yr	1 sem	2 sem	Yr
Circles, Fluency		-.20	-.15	-.23	.15	.01	.11	-.10	-.10	-.11	.05	.02	.04
" , Flexibility		-.07	-.04	-.09	.10	.06	.12	-.01	.01	.01	.17	.16	.18
" , Originality		-.08	.00	.07	.15	.14	.20	.02	.10	.07	.21	.10	.17
" , Elaboration		-.13	-.04	-.11	.19	.11	.18	-.01	.06	.03	.06	-.06	.01
" , Total		-.15	-.06	-.14	.20	.11	.20	-.02	.04	.01	.14	.03	.09
Improvements, Fluency		.13	-.05	.05	-.22	-.06	-.15	-.01	-.08	-.05	.10	.00	.06
" , Flexibility		.10	.02	.07	.01	.08	.07	.10	.07	.09	.16	.02	.11
" , Originality		.12	.06	.08	-.11	-.11	-.10	.04	-.05	.00	.12	-.06	.04
" , Elaboration		.06	.02	.06	-.18	-.17	-.23	-.06	-.12	-.09	-.07	.03	-.03
" , Total		.14	.02	.08	-.18	-.10	-.15	.02	-.07	-.03	.11	-.02	.06
Tin Cans, Fluency		-.14	-.14	-.18	-.02	-.10	-.07	-.15	-.17	-.18	.00	-.07	-.04
" , Flexibility		-.08	-.13	-.12	-.03	-.06	.04	-.10	-.04	-.07	-.02	-.15	-.08
" , Originality		-.19	-.03	-.17	-.04	-.12	-.03	-.16	-.11	-.15	-.08	-.14	-.12
" , Elaboration		.02	.08	.07	.01	.10	.07	.03	.14	.09	.18	.21	.22
" , Total		-.18	-.08	-.18	.01	-.07	-.01	-.17	-.11	-.15	-.03	-.11	-.07
Consequences 1, Fluency		.18	..21	.22	-.03	-.01	-.01	.16	.14	.16	.27	.20	.26
" , Originality		.11	.08	.11	-.10	-.03	-.07	.05	.03	.04	.19	.15	.19
" , Total		-.04	.11	.03	.06	-.16	-.08	.00	-.04	-.02	.08	.09	.09
Consequences 2, Fluency		.13	.16	.15	-.11	.14	.06	.06	.22	.16	.22	.08	.17
" , Originality		.06	.17	.09	-.16	.03	-.02	-.05	.15	.06	-.01	-.04	-.03
" , Total		.12	.19	.15	-.15	.09	.02	.02	.20	.13	.12	.02	.08

Table 14

Correlations between Ability Measures

and Achievement and Performance

All Groups (N = 74)

Measure		Achievement									Performance		
	Period	1st sem.			2nd sem.			Year					
	Material Covered	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr	1 sem	2 sem	yr
Grade Average (all subjects)		.34+	.34+	.39+	.07	.37+	.33+	.40+	.52+	.50+	.56+	.41+	.54+
" " (science)		.40+	.39+	.46+	.02	.35+	.29*	.41+	.55+	.53+	.51+	.38+	.48+
Gates Reading, Speed		.24	.25	.27	-.03	.20	.15	.22	.33+	.30*	.58+	.49+	.58+
" " , Vocabulary		.34+	.35+	.39+	.00	.16	.14	.34+	.37+	.39+	.54+	.34+	.49+
" " , Comprehension		.47+	.41+	.52+	.11	.34+	.32+	.55+	.55+	.60+	.63+	.36+	.56+
" " , Total		.46+	.44+	.53+	.00	.28	.22	.47+	.52+	.54+	.53+	.25	.45+
Intelligence, Verbal R.S.		.24	.38+	.34+	.02	.17	.16	.26	.40+	.36+	.56+	.32+	.50+
" , Verbal I.Q.		.26	.42+	.37+	.02	.18	.18	.27	.44+	.39+	.58+	.35+	.52+
" , Nonverbal R.S.		.35+	.45+	.47+	.04	.18	.17	.38+	.46+	.46+	.52+	.38+	.50+
" , Nonverbal I.Q.		.34+	.49+	.47+	.07	.20	.20	.39+	.50+	.49+	.54+	.42+	.53+

* r = .29 ($p < .05$) + r = .31 ($p < .01$)

and all of the performance scores. This group worked out-of-class at their own rates and the question was, "What might happen if the language of birds and animals could be understood by people?" Group III had seven other significant correlations, but they were quite scattered except for Improvements, fluency, which was correlated ($p < .05$) with all three performance scores. When all of the groups were combined, there were no significant correlations between any of the creativity measures and the performance scores.

With the possible exceptions of the patterns mentioned for Group III, it seems safe to conclude that creativity (as operationally defined by these measures) does not affect achievement or performance on programed learning.

Ability measures: When the dependent variables were correlated with the more widely used predictors of academic success, there were a number of significant correlations.

For Group I there were significant correlations between various Gates reading measures and achievement. The speed score was correlated with achievement of second semester materials for the second semester ($r = .65$; $p < .05$) and for the year ($r = .73$; $p < .01$) and with total achievement for the year ($r = .60$; $p < .05$). The vocabulary scores were significantly correlated with achievement for the first semester material and year's material for the first semester (r's = .55 and .54, respectively; $p < .05$) and with all of the achievement measures for the year (r's = .51 to .66; $p < .05$ to .01). The comprehension scores and the total score were significantly correlated with all achievement measures for the first semester and for the year (r's = .52 to .74; $p < .05$ to .01), but with none of the achievement measures for the

second semester.

There were significant correlations for Group I between the Lorge-Thorndike Verbal Raw Score and I.Q. for the year's achievement over second semester materials (r's = .69 and .68, respectively; $p < .01$) and with the year's achievement over all of the material (r = .52 and .51, respectively; $p < .05$). The non-verbal measures had the following significant correlations: raw score with first semester's achievement of first semester materials (r = .54; $p < .05$), with first semester's achievement over all material (r = .52; $p < .05$), and with year's achievement over all material (r = .53; $p < .05$); and, I.Q. with year's achievement with all material (r = .51; $p < .05$).

None of the ability measures were significantly correlated with any of the performance measures.

For Group II the over-all grade averages and the science grade average were significantly correlated with all of the second semester and year achievement measures and with all of the performance scores (r's = .50 to .66; $p < .05$ to .01). The Gates comprehension score was significantly correlated to second semester's achievement of first semester material and year's material (r's = .49 and .51; $p < .05$ and .01, respectively) and with year's performance (r = .42; $p < .05$). Verbal I.Q. was significantly correlated to first semester's and year's performances (r's = .44 and .40, respectively; $p < .05$). Non-verbal raw score was significantly correlated with second semester's achievement of second semester and year's material (r's = .58; $p < .01$), with all of the achievement measures for the year (r's = .41 to .61; $p < .05$ to .01), and with the first semester and year's performance scores (r = .63 and .54, respectively; $p < .01$). Non-verbal I.Q. was significantly

correlated with second semester's achievement of second semester and year's material and with the year's achievement over over the same materials (r's = .47 to .54; $p < .05$ to .01) and with first semester's and year's performance scores (r's = .57 and .51, respectively; $p < .01$).

For Group III all of the ability measures were significantly correlated with all of the first semester achievement scores (r's = .50 to .69; p's $< .05$ to .01), except for the first semester's achievement of first semester material with over-all grade average and with Gates speed score. All of the ability measures were significantly correlated with all of the achievement measures (r's = .50 to .89; $p < .05$ to .01), except with the non-verbal raw scores. However, there were only two significant correlations with the achievement measures. Second semester's achievement of second semester materials was significantly correlated with Gates speed score ($r = .61$; $p < .01$) and with Gates total score ($r = .58$; $p < .05$). Each of the ability measures was significantly correlated with each of the performance measures (r's = .53 to .84; p's $< .05$ to .01).

For Group IV all of the ability measures are significantly correlated to the first semester's achievement of second semester and year's materials (r's = .50 to .70; p's $< .05$ to .01), but first semester's material only with Gates comprehension and total (r's = .68 and .62, respectively; $p < .01$). There were no significant correlations between ability and second semester's achievement measures. The year's achievement measures were significantly correlated within the following relationships: over-all grade average with all achievement measures (r's = .48 to .58; $p < .05$); Gates comprehension with all achievement measures (r's = .56 to .66; p's $< .05$ to .01); Gates total with

achievement of second semester's material ($r = .54$; $p < .05$) and of year's material ($r = .54$; $p < .05$); non-verbal raw score with achievement of second semester's material ($r = .48$; $p < .05$); and, non-verbal I.Q. with achievement of second semester's material ($r = .53$; $p < .05$) and of year's material ($r = .47$; $p < .05$). Each of the ability measures were significantly related to the first semester's and year's performance scores (r's = .52 to .81; p's $< .05$ to .01), but none with the second semester performance scores.

When the groups are combined there are significant ($p < .01$) correlations between each of the ability measures and the first semester achievement scores, except verbal raw score and I.Q. with achievement of first semester material and Gates speed with any achievement measure. There are only six significant correlations involving achievement scores for the second semester (r's = .29 to .37; $p < .05$ to .01): achievement of second semester's and year's materials with over-all grade averages; with science grade averages; and with Gates comprehension. Each of the ability measures is significantly correlated ($p < .01$) with each of the year's achievement measures, except Gates speed with any measure and verbal raw score and I.Q. with achievement of first semester's material. Each of the ability measures is significantly correlated ($p < .01$) with each of the performance scores, except Gates total with second semester performance.

Partial Regression Coefficients

Since the more common measures of learner characteristics (i.e., grade averages, reading ability, and intelligence measures) are the ones related to achievement for the year, these were analyzed to determine

the relative weights of each when the over-lapping variances were partialed out. This was done using the Doolittle method (Peters and VanVorhis, 1940, pp. 226-234). The resulting regression coefficients (beta's) are:

Lorge-Thorndike, Verbal I.Q.	-.678
Lorge-Thorndike, Non-verbal I.Q.	.403
Gates Reading, Total	.328
Gates Reading, Comprehension	.258
Grade Average, All subjects	.169
Grade Average, Science	.145
Gates Reading, Speed	-.065
Gates Reading, Vocabulary	.064

Attitude Measures

For purposes of tabulation, each response to an item on the questionnaire was assigned a number depending on whether it was a positive or negative statement. The responses were coded 1 to 5, with a "strongly agree" to a positive statement being assigned a 5, and to a negative statement a 1. These numbers were summated for the score of each S. Table 15 gives the mean average and standard deviation for each administration of the test and gives the resulting t-score for the differences found for each group and for the groups combined. This table shows that each group dropped in its attitude towards programed instruction during the second semester and that each of these drops were statistically significant, except for Group IV. However, there were no significant differences between groups.

Tables 16 and 17 present the coefficients of correlation between

Table 15

Summary of Responses on Attitude Measures:

Mean averages, Standard deviations,

and t-tests

	Time of Administration					
	End of 1st sem			End of 2nd sem		
Group	N	M	sd	M	sd	t
I	15	180.44	17.32	166.11	20.56	2.714*
II	25	160.81	27.64	145.93	26.59	5.276+
III	16	175.39	22.51	154.22	28.80	3.612+
IV	18	163.51	24.53	155.13	32.20	1.223
All Groups	74	168.51	24.53	155.13	28.20	6.1362+

* $p < .05$ + $p < .01$

Table 16

Coefficients of Correlation between Attitude Change and Creativity Measures

Measure	Group I	II	III	IV	Total
Circles, Fluency	.38	.35	-.16	-.01	.08
" , Flexibility	.47	.39	-.42	.01	.08
" , Originality	.41	.19	-.08	.12	.08
" , Elaboration	.31	.12	-.25	-.10	-.10
" , Total	.49	.26	-.25	-.07	-.01
Improvements, Fluency	-.02	.18	-.18	.09	-.03
" , Flexibility	-.06	.02	-.59*	-.17	.20
" , Originality	.03	-.07	-.13	.04	.02
" , Elaboration	.04	.50+	-.14	.02	.15
" , Total	.00	.20	-.28	.04	.02
Tin Cans, Fluency	.16	.38	-.06	-.15	.07
" , Flexibility	.23	.11	.08	.05	.11
" , Originality	-.18	.14	.07	-.03	.05
" , Elaboration	.61*	-.09	-.34	-.12	-.06
" , Total	.07	.24	.03	-.10	.09
Consequences 1, Fluency	-.17	.10	-.58*	-.08	.20
" , Originality	-.14	.49*	-.60*	-.15	-.12
Consequences 1, Total	-.16	.23	-.61*	-.15	.00
Consequences 2, Fluency	.01	.23	-.73*	.02	-.05
" , Originality	.07	.40*	-.45	.09	.04
" , Total	.05	.39	-.63*	.06	-.01

* $p < .05$ + $p < .01$

Table 17

Coefficients of Correlation between Attitude Change and Aptitude Measures

Measure	Groups				
	I	II	III	IV	Total
Grade Average (all subjects)	.16	.03	-.50*	-.30	-.19
" " (science)	.16	-.10	-.50*	-.32	-.24
Gates Reading, Speed	.39	.06	-.25	-.12	-.01
" " , Vocabulary	.27	.04	-.30	-.19	-.08
" " , Comprehension	-.05	-.31	-.44	.01	-.21
" " , Total	.12	.05	-.36	-.05	-.11
Intelligence, Verbal R.S.	.15	-.07	-.39	-.35	-.17
" , Verbal I.Q.	.06	-.11	-.38	-.28	-.18
" , Nonverbal R.S.	-.18	-.10	-.38	-.15	-.19
" , Nonverbal I.Q.	-.15	-.06	-.40	-.07	-.19

* $p < .05$

attitude changes and learner characteristics. The presence of significant correlations are sporadic, except for Group III (out-of-class; own rate) where there are significant negative correlations between all but one of the measures from the creativity consequences tests and attitude change and between the grade average measures and attitude change.

Table 18 presents the coefficients of correlation between attitude changes and the achievement and performance measures. The first semester measures were omitted, since there was no measure of attitude change for the first semester. There were significant correlations between achievement for the year and attitude change for Group II ($r = -.30$; $p < .05$) and with Group IV ($r = .31$; $p < .05$).

Table 18

Coefficients of Correlation between Attitude Change and Achievement or Performance

Measure	Group I	II	III	IV	Total
Achievement 2nd semester	.24	-.27	.01	-.01	-.05
Achievement Year	-.08	-.30*	-.27	.31+	-.15
Performance 2nd semester	.28	-.12	-.16	.00	-.05
Performance Year	.27	-.26	-.24	-.15	-.15

DISCUSSION OF RESULTS

In this chapter is presented a discussion of the results reported in the preceeding chapter. The discussion is mainly organized around the four sub-problems stated in Chapter I. However, there were two instances where further analyses of the data were seen to be necessary in order to more adequately interpret the results. The results of these analyses are also included in this chapter.

Sub-problem #1--In terms of subject matter achievement, which method brings about the most learning?

There were no significant differences among the four treatment groups in terms of achievement over the content of the programed course. Before proceeding with a discussion of this finding, it would be helpful to review briefly the treatment groups.

The treatment was varied along two major dimensions: (a) in and out-of-class use of programs, and (b) student and teacher regulated discussions and tests. There were two in-class groups. One followed a teacher regulated schedule; that is, the teacher determined when the work on each unit was to be started and finished, and when unit tests were to be to be taken. The other group followed a student regulated schedule; that is, each student determined for himself when he would start and finish each unit, and when he would take each unit test. In both groups, the work on the programs was done under the supervision of the regular teacher who maintained discipline and was always available to answer questions.

There were two out-of-class groups. Both did all of their work on the program in locations other than in their general science classroom,

e.g., at home, in study halls, in some other classrooms, etc. One group followed a teacher regulated schedule, and the other a student regulated schedule. Both groups were required to report each day to their regular general science classroom where instruction on topics not covered in the program occured.

All groups were issued only one unit at a time, and were required to take unit examinations after each unit was finished and before the next unit was issued.

The in-class -- out-of-class variable.

With respect to the in-class and out-of-class variable, it should be noted that this finding of no significant differences in achievement do not agree with Barty and Darby's (1965) findings cited earlier. Their study involved college students in algebra for the duration of a summer term. The in-class "supervised" group was under the management of a student moniter. The present study involved eighth graders in general science for the duration of an entire nine month school term, and the in-class group was under the supervision of the regular classroom teacher.

The fact that the out-of-class groups achieved as much as the in-class groups in the present study is somewhat surprising in the light of Barty and Darby's findings favoring the in-class group. It does seem logical to expect that more mature students can work more effectively under unsupervised situations. Further the supervision and motivation that a regular teacher can provide may be expected to be superior to that which is provided by a student moniter.

The seeming contradiction above may be accounted for by the minimal

"supervision" that may have existed in the fact that the out-of-class groups in this study were required to turn in units as they finished and were required to take unit tests periodically throughout the school year. Moreover, learners on the student regulated schedules were not permitted to fall behind unduly. Malingerers were urged to proceed more rapidily. In Barty and Darby's study, the "non-supervised" group was simply handed programs and was told to return them at the end of the summer term. Some effect resembling supervision was probably operating with the out-of-class groups in the present study.

Another difference which may have influenced the achievement of the out-of-class groups was that, in this study, the subjects were required to report to their regular general science classroom each day. The subjects were constantly reminded that they were being held accountable to <u>their teacher</u> for the work on the program. In Barty and Darby's study, the out-of-class group met, as a class group, once in the beginning of the term when the programs were handed out, and again at the end of the term when they returned the programs and took an achievement test.

The no significant difference in achievement result of this study in no way testifies to the impotence of the teacher when programed instruction is being utilized. The involvement of the teacher in this study insofar as the content of the programed course was concerned was designed to be minimal. He was permitted only to answer student questions directly, and, for the out-of-class groups, their in-class time was spent on material not related to the content of the course.

The results might have been different had the teacher been permitted to explain and elaborate on the programed material with lectures,

demonstrations, and other types of materials. It seems reasonable to hypothesize that the group receiving the highest degree of teacher involvement in the mediation of the programed material would achieve the highest degree of mastery over the course content. In any case, this study did not shed any light on the question of how a teacher might enhance the effectiveness of programed instruction.

The most important implication of the no significant difference in achievement result is that the in-class use of programs with the teacher acting as only a little more than a monitoring agent is a waste of staff resources. The same gains in subject matter achievement might be made through out-of-class use of programs without the presence of the teacher. Barty and Darby's findings seem to indicate that in-class supervision by a sub-professional monitor might also do as well.

On the other hand, this study indicates that, where out-of-class use of programs is contemplated, it must require periodic (about once a week) check on student progress throughout the school term. In addition, the learner must perceive that his work on the program is being evaluated by someone of recognized status (i.e., my teacher). These two conditions appear to be essential, at least for junior high school students. Beyond the above, this study does not attest to the reliability of out-of-class use of programed courses.

The teacher regulated -- student regulated schedule variable.

This variable, teacher and student regulated schedules, involved the scheduling of units in the programed course. The teacher regulated schedule could be characterized as group-paced work on units, and the student regulated schedule as self-paced work on units. This is to be differentiated from group and self-paced work on individual frames.

The manipulation of this variable, likewise, produced no significant differences in achievement. The general conclusion to be drawn from this finding is that students working on self-determined schedules achieve as well as students working on teacher-determined schedules.

This interpretation must be qualified by pointing out that the teacher scheduling of units was spread out evenly throughout the year. The assignment of units was paced so that it would take the full school year to complete the work on the programed course. Those on student regulated schedules were not permitted to fall to far behind in their work. It was made clear to them that they were expected to be finished with the first half of the course by the end of the first semester, and the entire course completed by the end of the year. They also understood that their teacher would see to it that they did complete the program as stipulated.

It is quite likely that, for most of the students (whether teacher or student regulated), the scheduling of units was leisurely enough to permit self-pacing of their frame by frame work on the program; that is, it is quite likely that most of the subjects did not feel that they were being rushed into completing any portion of the program. It seems safe to say that the frame to frame work on the program was self-paced for virtually all subjects.

Seen in this light, the fact that there were no significant differences in achievement is not surprising. It is important to note, however, that the great majority of the students completed their work on the program without undue pressures being brought to bear on them. On the other hand, it is interesting to speculate about the effects of a more rapid pacing of unit assignments.

Sub-problem #2--Is subject matter achievement through programed instruction affected by individual learner characteristics?

Creativity.

In this study creativity did not generally correlate with achievement. The very few exceptions noted within groups are so random in nature that they defy description insofar as educational implications are concerned. Several things must be pointed up in considering this data on creativity. First, and foremost, the measurement of the concept of creativity as a basic learner characteristic is in its earliest developmental stages and, therefore, what creativity tests purport to measure and what they actually measure may, in fact, be two entirely different things. Secondly, in this study as in other studies, the experimental design may be an important factor insofar as the relationship of creativity to results is concerned -- one cannot generalize to the effects of creativity on achievement under other modes of use (e.g., more direct teacher involvement). Therefore, it can only be concluded that given the limitations of present creativity measures a school system using programed materials similar to the ways they were utilized in this investigation need not fear a loss of achievement by the creative student; nor should it be expected that the creative characteristics of students will promote significant gains in achievement.

Learning Ability.

Significant positive correlations between learning ability (reading ability and I.Q.) and achievement were noted. When all treatment groups are considered as a whole, first semester and total year achievement measures correlated significantly with almost all categories of reading and intelligence measures. These results indicate that programs of

the type used in this study do not by themselves adequately minimize the problem of the individual differences in learning ability. They do not obviate the effects of differences in reading ability and I.Q. on subject matter achievement. To put it in other words, the use of such programs do not result in the absorption of differences in learning ability through the small steps and self-pacing features of programed instruction as early advocates of programed instruction hypothesized.

This general evaluation of the relationship between learning ability and achievement must be qualified in the light of two additional findings. First are the inconsistencies in the correlations when the treatment groups are considered seperately. Second is the apparent contradiction in the correlations obtained when the second semester achievement was used.

Significant correlations between first semester and total year achievement measures and reading ability and I.Q. measures are somewhat scattered for groups I and II, the two in-class groups. For Group I, the first semester achievement measure did not correlate significantly with I.Q., either verbal or non-verbal. Besides the significant correlation with non-verbal I.Q., both the first semester and total year achievement measures failed to correlate significantly with learning ability for Group II. However, significant correlations were found more consistently for Groups III and IV, the two out-of-class groups. With only one exception the first semester achievement measure correlated significantly with all measures of reading ability and intelligence. Although for Groups III and IV, the total year

achievement measure did not correlate significantly with I.Q., it does seem that individual differences in learning ability affects out-of-class study of programs more than they do in-class study of programs.

The results were almost completely different when the second semester achievement measure was correlated with reading ability and I.Q. Except for some scattered instances found for Group II, the significant correlations observed between first semester achievement and learning ability did not appear with the second semester achievement. To a large extent the significant correlations appeared again when the total year achievement measure was used.

These results seem to indicate that the prolonged use of programed instruction tends to reduce the influence of individual differences in learning ability on subject matter achievement. This conclusion, however, needs to be qualified and is further discussed below.

Over-all Grade Average and Science Grades.

Correlations were also obtained between over-all grade average and seventh grade science grade, and the three achievement measures taken. The results were quite similar to those for reading ability and I.Q.

When all groups are considered as a whole, first semester and total year achievement measures correlate significantly with over-all grade average and seventh grade science grade. This indicates that the same learners who achieve most through "conventional" instruction also achieve most from programed instruction. This relationship is consistent with the positive correlations involving reading ability and I.Q., inasmuch as these measures also correlate positively with

achievement through "conventional" instruction.

This general relationship between achievement and previous grades must be qualified in the light of the results when the groups were considered separately and when the second semester achievement measure was used. Positive correlations were obtained more consistently between previous grades and achievement with Groups I and II (the two in-class groups) than for Groups III and IV (the out-of-class groups). This finding, together with the finding that individual difference in learning ability is more strongly correlated with achievement through out-of-class use of programs, indicates strongly that out-of-class use of programs is more effective among high ability learners.

Different results were again obtained when the second semester achievement measure was used. When the groups are considered as a whole, the significant correlations observed between previous grades and first semester achievement failed to appear with the second semester achievement measure. To the extent that learning ability is positively correlated with previous grades, this finding is consistent with the finding that prolonged use of programs tends to minimize the effects of individual differences on achievement through programed instruction. Further discussion of this point is made below.

Second Semester Achievement.

The analysis of the second semester achievement measure produced results that were somewhat unexpected. Two of these have already been noted. They are the loss of significant correlations between achievement and reading ability and I.Q. A similar loss was noted with previous grades. In addition there was observed a startling drop in mean

achievement for the second semester. The mean achievement for the first semester was 25.39, as compared to the mean achievement for the second semester of 9.36. Further, the analysis of performance data indicated no significant correlations between second semester achievement and any of the three measures of performance. (Significant correlations were obtained between first semester achievement and the three measures of performance.) Still further, there was no correlation between first semester achievement and second semester achievement (in fact, a very slight negative correlation was obtained).

The apparent implication of these results is that a profound reduction in the effectiveness of the programed course had occured during the second semester. It was decided, however, that further analyses of the data were required before any conclusions could be drawn. These analyses were directed toward two questions: (a) are there significant correlations between raw scores on the criterion test for the programed course and learner characteristics?; and, (b) how much of the reduction in achievement for the second semester was due to forgetting of first semester content?

Correlations were determined between raw scores on the criterion test and learner characteristics. Tables 19 and 20 summarize the correlations between the raw scores on the criterion test and the learner characteristics. These data indicate practically no significant correlations between creativity measures and raw scores on the criterion test. The only significant correlations are so scattered that they provide no real information and may be due to chance. However, each of the ability measures is significantly correlated ($p < .01$) to each

Table 19

Coefficients of Correlation between Raw Scores on Criterion Tests and Creativity Measures

All Groups (N = 74)

Characteristics	Pre-Test	Post Test 1	Post Test 2
Circles, Fluency	-.04	-.18	-.06
" , Flexibility	.03	-.02	.06
" , Originality	.11	.05	.18
" , Elaboration	.02	-.07	.02
" , Total	.04	-.07	.05
Improvements, Fluency	-.03	.01	-.02
" , Flexibility	-.06	.01	.04
" , Originality	.12	.14	.12
" , Elaboration	.31+	.26	.10
" , Total	.11	.12	.08
Tin Cans, Fluency	-.09	-.19	-.13
" , Flexibility	-.16	-.20	-.09
" , Originality	.03	-.11	-.05
" , Elaboration	.19	.18	.16
" , Total	-.14	-.06	-.03
Consequences 1, Fluency	.20	.29*	.22
" , Originality	.30*	.22	.22
" , Total	.09	.08	.03
Consequences 2, Fluency	.18	.24	.19
" , Originality	.24	.23	.18
" , Total	.24	.27	.20

* r = .29 ($p < .05$) + r = .31 ($p < .01$)

Table 20

Coefficients of Correlation between Raw Scores on Criterion Tests and Ability Measures

All Groups (N = 74)

(Note: All r's significant at at least p = .01.)

Characteristics	Pre-Test	Post Test 1	Post Test 2
Grade Average (all subjects)	.60	.70	.70
" " (science)	.61	.75	.72
Gates Reading, Speed	.47	.53	.51
" " , Vocabulary	.54	.65	.59
" " , Comprehension	.50	.72	.70
" " , Total	.48	.70	.66
Intelligence, Verbal R.S.	.67	.71	.63
" , Verbal I.Q.	.66	.72	.64
" , Nonverbal R.S.	.38	.60	.57
" , Nonverbal I.Q.	.41	.61	.60

of the criterion test performances. These analyses gave no further information for the problem being investigated.

Since the criterion test was divided into two sections of equal length, each covering the programed material for a specific semester, an analysis was made to determine the amount achieved for these materials each semester. Table 21 gives a summary of the mean achievements for each group. This indicates that the programs for each semester brought about some improvement in the achievement in the material of the other one. That is, there was no drop in the achievement scores on the first semester materials during the second semester. This underscores the fact of a lesser amount of achievement being accomplished by the groups during the second semester. Analyses of variance show that there are no significant differences among the groups on these measures. However, there are two interesting observations on the second semester measures: first, Group I showed practically no improvement on first semester materials, but definite improvement on the second; and, second, Group IV showed more improvement on the first semester material.

These results indicate that the reduction in achievement during the second semester when compared with first semester achievement was not due to forgetting of first semester content. The two generalizations made earlier have been sustained. First, is that there is a decided reduction in the effectiveness of programed instruction during the second half of a year-long use of programed instruction. Second, is that the prolonged use of programed instruction (a whole school year) tends to reduce the effects of differences in learning ability on subject matter learning. This reduction of effect, however, is due as

Table 21

Mean Achievement Measures by

Semester's Material Covered

Achievement Measure	Group I	II	III	IV
First Semester				
1st sem. material	20.06	15.84	13.44	10.89
2nd sem. material	5.33	12.24	12.81	10.28
Second Semester				
1st sem. material	.34	3.20	2.19	3.72
2nd sem. material	11.54	5.88	4.76	2.67
Year				
1st sem. material	20.40	19.08	15.63	14.61
2nd sem. material	16.87	18.12	17.57	12.95

much to the better students falling off in their achievement as to any other factor.

The loss of correlation between second semester achievement and learning ability together with the large drop in mean achievement from first semester achievement strongly suggest that the higher ability learners were affected more by whatever inhibiting factors that may have been present during the second semester.

The generality of these results, however, must be limited to the particular way in which the programed course was employed in this study. The negative shift in attitude seems to indicate that there was a decided loss of motivation among the learners. The research design precluded any active involvement on the part of the teacher in the teaching of the content of the program, or to employ any other means for stimulating interest in the program than the usual classroom disciplinary measures, i.e., the threat of failure and poor grades. As far as the work on the program was concerned, the subjects had no relief from forced responses to small bits of information. Over the long haul, it appears that this had an adverse effect on the interest of the learners.

Sub-problem #3--Is performance on the programed instruction affected by the method of utilization employed?

As in the case of achievement, there were no significant differences among the four groups as far as their performances were concerned. That is, the groups did equally well in writing out their responses to the individual frames: they did their assigned work equally well. Of course, the observation made earlier about the degree of "no supervision" in these methods is applicable here, since the Ss did have to

account to their teacher even though they were working out-of-class or at their own rate of speed. Thus, doubtless many of the pressures usually working in our classrooms were operating here to cause the Ss to get the work done. This would indicate that if the programs were utilized in the manners suggested in this study, one need not fear that the students would fail to carry out their assignments, even though the teacher is not always present to give supervision. For the out-of-class usage method, one might be willing to hypothesize that the students will go through their work on the program better than they would go through the traditional textbook homework assignments.

Of particular interest in these data is the fact that there was not the drop in performance that was found in achievement during the second semester. That is, in spite of the fact that there was a decided drop in the achievement of the second semester, as measured by the criterion test, the Ss continued to operate at a high level as far as writing correct answers for each frame was concerned. This has some implications for learning theory and the concept of reinforcement utilized in programed learning. This will be discussed later in this chapter.

Sub-problem #4--Is performance on programed instruction affected by individual differences in learner characteristics?

Again, as in the achievement evaluation, there was little indication that creativity, as measured by the Torrence test, had much effect on the performance of the Ss on this program. For the groups and for the combined groups there were only a few scattered significant relationships. The one exception to this was Group II, the group that was put on its own to the greatest degree in that it worked out-of-class at

its own rate. For this group there were 16 significant correlations between creativity measures and performance. Further, these seemed to cluster around the Consequences tests and the Improvements tests. Although one would be reluctant to be too specific about the meaning of this relationship, there seems to be some basis for speculating that the more creative student will do better at working at a new instructional technique than a less creative student, when the student must take the larger responsibility for getting the work done.

When one looks at the correlations between the more traditional educational measures of individual differences (i.e., reading and intelligence measures and past school records), one begins to see the more common relationships with performance. When the data for all the groups are combined there are significant correlations among practically all of the variables. This would indicate that these individual differences brought into the situation by the learners do affect the way they work on programed learning. These findings are in harmony with those of Hatch and Flint (1962) and Woodruff, Faltz, and Wagner (1965) which indicated that such factors as intelligence and reading ability are intercorrelated with error rate and performance.

When the groups are compared on these significant correlations, it is readily apparent that Groups III and IV, the ones under less direct supervision since they worked on their programs out-of-class, showed more of the influences of individual differences. Group I had no significant correlations between these variables and Group II had the next least number. Group III had significant correlations between all of them and Group IV had them among all but the second semester performance

correlations. This indicates that the more the student is on his own, the more the commonly found effects of individual differences in the classroom will show up in programed learning, if his frame-by-frame behavior is being evaluated.

Since other studies are more concerned with achievement than with performance, as defined in this study, it is difficult to compare these data with others. As was indicated above, there is agreement between these and other data regarding the intercorrelation of intelligence or reading ability on performance. There are no comparable data on the possible effects of creativity on this behavior. However, Woodruff, Faltz, and Wagner (1965) did find relationships between personality dimensions and performance on programed learning. This might lead one to hypothesize that such a relationship should be found regarding creativity. However, with the exception of the one group (Group III), there was not the slightest suggestion of this.

Before leaving this discussion, a point suggested earlier should be re-introduced. This has to do with the general low level of achievement displayed during the second semester, while the performance scores remained high. That is, the Ss wrote the right answers and saw that they were correct ("reinforcement"), but they did not learn, as defined by achievement scores. The simplest contiguity of response and knowledge of results did not bring about satisfactory learning. Along with this one should recall the drop in favorable attitude towards this instructional technique. Possibly this is a cue to what is happening here. With the drop in attitude there could be an accompanying drop in organismic motivation to learn. (No attempt is made here to

define this motivation.) In order for learning to take place there must be a reduction of this motivation as well as the contiguity of the events suggested above. This, of course, is in harmony with most learning theories. It just suggests that the same principle is in operation here.

Students who are most efficient in programed learning.

The data discussed above, plus the partial regression coefficients, have some implications for the assignment of pupils to programed instruction, when such an option is available. Although the variables that have significant correlations with achievement on programed learning are not markedly different from those that are significantly related in most teaching techniques, possibly an observation or two might be in order. The consistent finding that both the speed and comprehension scores in the reading test used in this study are valid predictors of both performance and achievement suggests that special attention should be paid to the general reading ability of students who are to be assigned to or who seek enrollment in a programed course. The highly significant correlations between reading and achievement and performance for the year provide additional evidence of the importance of good reading speed and comprehension. The rather high regression coefficients after the common variance with intelligence had been partialled out of reading comprehension and the total Gates score further emphasize this. Therefore, it would seem inadvisable to schedule those students who have demonstrated below average reading ability into courses which use programed instruction extensively. On the other hand, of course, one should not hesitate in permitting good readers to enroll in such courses, should they so desire. It would, in fact, seem that as a method of instruction, programed instruction would allow these

students to utilize their reading skills to optimum advantage in the process of learning.

The consistency of contribution of the nonverbal I.Q. score as a predictor of both performance and achievement connot be ignored in assigning students to programed instruction. Even when the common variances with other predictors are partialled out, it still had a regression coefficient of .40 with year's achievement. In view of this it would seem that information of the type provided by a non-verbal intelligence battery would give some additional insight into the probable performance and achievement of a student in a programed course. The high negative partial regression coefficient of verbal I.Q. with year's achievement (-.68) is rather difficult to interpret. Probably, the common variance with the reading measures and school grade averages may give some meaning to this.

Although various creativity test scores appear as making significant contributions as predictors of performance and achievement, with respect to the predictive validity of the creativity scores for programed learning as shown in this study, it should be noted that there is a rather random selection with respect to the various types of creativity which have made predictive contributions. Therefore, much of what can be said about the predictability of a creativity test for performance and achievement in programed learning must remain in the realm of conjecture and speculation.

Change in Attitudes of Students.

Although the attitude measures were really incidental to this study, the results do merit some comment. All of the groups, except

IV, showed a significant drop in the degree of favorable attitude towards programed instruction, and even Group IV showed a drop. However, before too much can be made of this, it must be recalled that there was no "no-programed learning" control group in this study. Therefore, one can only speculate as to whether there is a general drop in favorable attitude towards school and school subjects, regardless of technique of instruction used. Yet, this drop in favorable attitude cannot be ignored and may help to explain some of the results, as was suggested earlier in this chapter. Only two groups, II and IV, had significant correlations between year's achievement and attitude change, but Group II was -.30 and Group IV was +.31. The difference between these two groups was on the in-class--out-of-class dimension, since both worked on a teacher-paced schedule.

When attitude change was related to learner characteristics, one group of results give some indication as to what students will show less drop in attitude. In Group III, the one most on its own, the Ss showing the most creativity, as indicated by the Consequences tests, had the least drop in attitude towards programed instruction. That is, they were better able to deal (attitudinally) with the new technique of teaching, when they had to take responsibility for learning.

Aside from the above observation, not much can be conclusively stated about methods of utilization of programed instruction or learner characteristics and achievement. (Performance tends to hold up regardless of attitude.) Yet, teachers must consider it as a possible factor influencing the efficiency of learning whenever programed materials are used extensively.

Summary and Recommendations

SUMMARY

This study involved 74 eighth graders and their year-long work on a programed course in general science. The subjects were divided into four treatment groups varied as to (a) in or out-of-class use of the program, and (b) teacher or student regulated scheduling of units.

Two measures were taken: (a) an achievement measure over the subject matter content of the programed course, and (b) a performance measure, i.e., number of correct frame-to-frame responses.

These measures were related to (a) method of program use (treatment) and, (b) individual learner characteristics.

The findings of the study are summarized below:

1. Achievement and method of use. There were no significant differences in subject matter achievement among the four treatment groups. The programed course was equally effective whether the work was conducted in-class under the supervision of a regular teacher, or out-of-class where learners were on their own. Neither did it matter whether the teacher regulated the assignment of units and the taking of unit examinations, or whether students set their own schedules of work on the program and the taking of examinations.

In this study, however, it was clear to all learners that they were held accountable for their work on the program to their regular general science teacher. Further, all out-of-class groups met daily with their teacher during the regularly scheduled general science period. These two conditions was seen to be important in contributing to the effectiveness of out-of-class use of programs.

2. Achievement and individual learner characteristics. The individual learner characteristics considered could be categorized into three groups: (a) creativity, (b) previous grades, and (c) learning ability.

(a) Creativity. Among the 21 separate creativity measures taken, only scattered significant correlations with achievement were observed. These did not occur consistently with the several measures of achievement that were taken, e.g., pre-test, end of first semester post-test, end of second semester post-test. The general conclusion is that the various creativity attributes do not effect learning from programed instruction. This is probably more a commentary on the pristine state of the science of creativity measurement than an indication that creativity is in fact unrelated to learning through programed instruction.

(b) Previous grades. Achievement was also related to over-all grade average and science grades at the end of the seventh grade. With the exception of the second semester achievement measure, all measures of achievement (i.e., first semester and total year achievement) correlated significantly with previous grades. It appears that those who achieved well under "conventional" teaching procedures also achieve well through programed instruction.

(c) Learning ability. Both reading ability and I.Q. were considered as measures of learning ability. Again, with the exception of the second semester achievement measure, all measures of achievement correlated significantly with learning ability. There were some exceptions within groups and differences among groups, but, when all subjects were considered together, the significant correlations appeared consistently with all measures of reading ability and I.Q. taken. It does appear

that reading ability is a key variable in learning effectively from the type of program employed in this study. It appears, also, that the linear, constructed answer type of program does not meet adequately the problem of individual differences in learning ability.

3. When the results of the analyses utilizing the first semester achievement measure are compared with the results obtained with the second semester ahcievement measure, some unexpected differences were observed.

a. There was a large drop in mean achievement during the second semester. It seems likely that the continuous use of programed instruction over a prolonged period would lead to a reduction in its effectiveness.

b. The significant correlations between learning ability and first semester achievement largely failed to reappear with second semester achievement. Although these correlations did appear with total year achievement, it seems possible to conclude that the prolonged use of the program resulted in the negation of the effects of differences in learning ability on subject matter achievement. This loss in correlation appeared to be due more to the drop in achievement among higher ability than among the lower ability learners.

c. The drop in mean achievement and the loss in correlation between achievement and learning ability, together with a negative shift in attitude toward programed instruction, indicate that there occured a loss of interest among the learners during the second semester. The results might have been different had the teacher been encouraged to actively relate other classroom activities to the programed course.

RECOMMENDATIONS

The findings of this study have implications for (a) school practice relative to the utilization of programed instruction, and (b) learning principles as they have been applied to the characteristics of programed instruction. These implications are here translated into specific recommendations. In addition, some recommendations for further are also included.

Recommendations for school practices.

1. Out-of-class use of programed courses is recommended. Such use, however, must be predicated on careful provisions for assignment of students under the jurisdiction of a recognized person of authority, i.e., the regular teacher. Learners at all times must be aware that someone whom they respect will hold them accountable for their work on the program.

Out-of-class use of programed courses should make possible the following provisions in the school program, which, heretofore, have been obviated by the necessity for direct teacher mediation of learning in group instructional situations:

a. Students may be assigned to teachers on a "case-load" basis. This means that closer attention could be given to the scheduling of individual students as opposed to groups of students. Inasmuch as the teacher would work with one student at a time, the evaluation and guidance of learning could become an individualized matter. Thus employed, programed instruction could depart to some extent from the lock-step graded system presently operating in most schools.

b. A programed course may be used to teach the basic content of a course on a homework basis. This would affect the way in which

teachers handle the teaching-learning process within the classroom. In-class work could emphasize enrichment and remedial objectives. Socialized learning activities could be employed more freely, especially since working on programs reduces opportunities for social interaction in the instructional process. Group discussions on individual and local applications of concepts and principles could be held more frequently. Committee work on research and creative projects could be conducted more extensively.

c. Programed instruction could be used effectively in the independent study portion of the NASSP Staff Utilization Plan (Trump, 1958) for the organization of instruction (team teaching). Especially for educationally motivated students, programs lend themselves for location in study carrels.

d. Programed courses could enable schools with limited curricular offerings and limited staffs to expand their curriculum, particularly for average and above average learners. They could alleviate to some extent the disadvantages of limited academic programs in small rural schools.

e. By the same token, programed courses could extend the school's ability to provide accelerated programs. College level programed courses could be assigned to academically talented students who are able to handle more course work than can be offered in a five or six period school day.

2. This study indicates that there is a drop in the degree of favorable attitudes towards programed instruction with extensive use on the part of the students. Although certain questions can be raised about the validity of this measure, the findings can not be ignored.

Therefore, the teacher who plans to use programed instruction as a primary technique must attempt to combat this attitude change.

Recommendations for further research.

3. This study indicates, as have numbers of previous studies, that investigations in programed learning can give important data on the learning process itself, as well as data on the application of learning principles. The question concerning reinforcement suggested earlier and the functional relationship of learner characteristics to the learning activity are suggestions of this. Such data can be important in the development of learning theory.

4. A question that comes out of this study is concerned with the desired nature and extent of teacher involvement in teaching the content of a course by programed instruction. In this study the teacher involvement was kept to a minimum, but this is not suggested as ideal. However, there is a need for controlled empirical evidence to provide some suggestions as to what the "ideal" involvement should be.

5. In scoring the programs, certain sequences of responses seemed to be made by some of the students. It might be that these are related to certain learner characteristics. Or, they might give some behavioral indication as to when the drop in favorable attitude takes place. A study of these responses sequences might prove meaningful.

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Appendix A

Division of Topics, Units, and Number of Frames for Each Semester

First Semester

Biology & Chemistry

Combined Units

Biology - Vol. I			Chemistry - Vol. II		
Text Units Included	Unit I	No. of Frames	Text Units Included	Unit I	No. of Frames
1	Intro. to Cell Structure	150	1	Matter	106
2	Plastids	21 171	2	Energy	53 159
	Unit II			Unit II	
3	Nucleus	43	3	Symbols & Formulae	42
4	Cytoplasm	74 117	4	Physical & Chemical Change	68 110
	Unit III			Unit III	
5	Animal & Plant Cells	31	5	Atomic Theory	73
6	Protozoa	39		Unit IV	
7	Tissues, Organs & Systems	50 120	6	Oxidation	23
			7	Metal & Non-metals	28
	Unit IV		8	Acids, Bases & Salts	50 101
8	Green Plants	183		Unit V	
	Unit V		9	Organic Chemistry	35
9	Mitosis	102	10	Analysis	51 86
10	Reproduction of Seed Plants	107 209		Unit VI	
	Unit VI		11	Protons, Neutrons & Electrons	61
11	Animal Reproduction	217	12	Isotopes & Ions	40 101
	Unit VII				
12	Men in Biology	39			
13	Classification	123 162			

FIRST SEMESTER UNITS (continued)

Biology - Vol. I

Text Units Included	Unit VIII	No. of Frames
14	Heredity	99

Chemistry - Vol. II

Text Units Included	Unit VII	No. of Frames
13	Radioactive Materials	95
14	Chain Reactions	46
15	Laboratory Equipment	64
		205

Work and Machines

Combined Units

Text Units Included		No. of Frames
	Unit I	
1	Matter, Energy and Work	201
	Unit II	
2	Power and Horsepower	48
3	Introduction to Machines	88
		136
	Unit III	
4	Mechanical Advantage	111
5	Efficiency and Friction: Coefficient of Friction	154
		265
	Unit IV	
6	Hydraulic Machines	103
	Unit V	
7	Laws of Motion	220
8	Floating Objects - Archimedes Law	38
		258
	Unit VI	
9	Introduction to Engines	80
10	Transportation and Engines	157
		237

FIRST SEMESTER UNITS (continued)

Measurement, Meteorology & Astronomy

Combined Units

Measurement - Vol. I

Text Units Included	Unit I	No. of Frames
1	Intro. to Measurement	16
2	Intro. to Metric System	15
3	Measuring Length	98
		129
	Unit II	
4	Measuring Weight	34
5	Measuring Speed	20
6	Measuring Heat and Temperature	22
7	Measuring Volume	28
8	Added Material and Review	37
		141

Total number of frames (First semester): 3,583

Second Semester

Measurement, Meteorology & Astronomy

Combined Units

Meteorology - Vol. I

Text Units Included	Unit I	No. of Frames
1	Intro. to Conditions of the Atmosphere	27
2	Convection	95
		122
	Unit II	
3	Humidity and Intro. to the Water Cycle	58
4	Families and Kinds of Clouds	34
5	Precipitation, Frost & Dew	77
6	Water Cycle	23
7	Water Shortage	21
		213
	Unit III	
8	Earth's Motion in Space	119
	Unit IV	
9	General Air Movement	77
10	Highs and Lows	98
11	Air Masses and Fronts	84
12	Storms	51
		310

Astronomy - Vol. 2

Text Units Included	Unit I	No. of Frames
1	Intro. to Astronomy	135
2	Great Men in Astronomy and Instruments of Astronomy	78
		213
	Unit II	
3	The Earth and the Sun	157
	Unit III	
4	The Moon, Natural Satellites and Artificial Satellites	108
5	Six Planets Closest to Sun	114
6	Three Planets Beyond Saturn	47
		269
	Unit IV	
7	The Planets: Size & Distance from the Sun	102
8	Comets & Stars	74
9	Longitude & Latitude	51
10	Magnitude of Stars	17
		244

SECOND SEMESTER UNITS (continued)

Sound, Light, Electricity & Communications

Combined Units

Sound - Vol. I

Text Units Included	Unit I	No. of Frames
1	Vibration	12
2	Speed	64
3	Pitch & Amplitude	24
		100
	Unit II	
4	Oscilloscope	19
5	Wavelength	11
6	Rarefaction & Compression	13
7	Acoustics	16
8	Producing Sound	22
9	Quality of Sound	8
10	Review	10
11	The Ear	41
		140

Light - Vol. 1

	Unit I	
1	Intro. to Light	61
2	Mirrors & Lenses	64
3	Reflection & Light Waves	52
		177
	Unit II	
4	The Eye	75
5	Color	86
6	Shadows & Brightness	44
		205

Electricity - Vol. 2

Text Units Included	Unit I	No. of Frames
1	Static Electricity	163
	Unit II	
2	Cells & Batteries	49
3	Ohm's Law	113
4	Electrical Measuring Devices	17
		179
	Unit III	
5	Magnets	104
6	Generators	24
		128
	Unit IV	
7	Electric Current	52
8	Circuits	74
9	Fuses & Circuit Breakers	21
10	House Wiring	32
		179
	Unit V	
11	Electrical Power	54
12	Electrical Energy	60
		114

SECOND SEMESTER (continued)

Communications - Vol. 2

Unit I

Text Units Included		No. of Frames
1	History of Communications	41
2	Telegraph	41
3	Telephone	64
		146

Unit II

4	Radio	118

Unit III

5	Television	174

Total number of frames (second semester): 3,469

Total number of frames (year): 7,052

Appendix B

List of Supplementary Materials, with Examples

EXAMPLES OF SUPPLEMENTARY MATERIALS USED

I. Titles of films and filmstrips.

A. Filmstrips

1. Whys of Elementary Science Series (Filmstrip House)

a. Set XI--The Astronaut and Space Travel, Nos. 1, 2, 3 and 4.

b. Set XII--The Sea, Nos. 1 and 2.

2. Earth Science Series (SVE)

a. Life Long Ago Group (6 filmstrips)

3. The Earth and the Universe Series (SVE)

a. The Earth in Space

b. Work of Astronomers and Space Travel

4. How We Get Our Clothing Series (SVE)

a. The Story of Cotton; Leather; Wool; and Rubber

5. Soil Conservation Series (EBF)

a. How Man Conserves the Soil

b. Water and the Soil

c. How Man Has Used Soil

6. The Microscope and Its Use (SVE)

a. Introduction to Microscope.

b. Introduction to Algae

7. Conservation is Everybody's Business Series (Popular Science)

a. People--Valuable Resource

b. Using our Forests Wisely

SUPPLEMENTARY MATERIALS (continued)

8. Conserving Our America Series (SVE)
   a. Controlling Erosion in Fields and Woods
   b. Forest Fires
   c. How Nature Defends Soil
   d. Aiding Wildlife of Wood Lots and Forests

B. Films
   1. Birth of the Soil, 11 min., Color
   2. Development of Communications, 11 min., B&W
   3. Exploring the Universe, 11 min., B&W
   4. Life in a Drop of Water, 11 min., B&W
   5. Man in Space, 35 min., Color
   6. Soil and Water Conservation, 10 min., B&W
   7. Volcanoes in Action, 11 min., B&W
   8. The River, 30 min., B&W
   9. Kilauea: Eruption 1960, 40 min., Color

II. Lessons illustrated by 2 x 2 slides.

A. Example: Volcanoes

Slide #1 Introduction:

Because volcanoes present such a weird and violent spectacle, they have been a source of awe and fear to man through the ages. Actually, though they occasionally take great tolls, volcanoes are the cause of less destruction than are earthquakes.

Perhaps the most famous eruption occurred in 79 A.D. when Vesuvius completely buried two

SUPPLEMENTARY MATERIALS (continued)

Roman cities under a suffocating blanket of ash and cinder many feet thick. About 2000 people perished in the buried Pompeii and Herculaneum.

Slide #2

Here, in a more recent eruption on the island of Bali in March of this year (1963), we get a glimpse of a volcanic aftermath. Balinese rice-land, ruined, lies under a blanket of hot ash and sulphurous steam . . . in places three feet deep.

However, here as in Roman times, the volcano gave warning as they usually do, and the majority of the people escaped.

Rarely, if at all, does a great volcanic eruption occur without an accompanying movement of the earth's crust. Volcanoes occur in *definite geographic areas.*

Slide #3

Here are shown the location of the world's known volcanoes. Notice how they are grouped into definite chains. These are the areas of great faults or cracks in the earth's crust. It is along these same faults that the majority of earthquakes occur. Thus, it is apparent that there is a relationship between earthquakes and volcanoes although we don't know exactly what it is.

Although we don't know the exact cause of volcanoes, volcanologists have learned a great deal since Pompeii and Herculaneum.

SUPPLEMENTARY MATERIALS (continued)

Slide #4

Somehow, either through a reduction in pressure or an increase in temperature, rock in a pocket of the earth's crust becomes molten. By means of cracks or faults in the earth's surface, this molten rock or magma works its way to the surface.

When the magma reaches the surface it may pour forth as a gentle flow of lava. If the magma should contain a large amount of hot gases, however, it may burst forth explosively, throwing rock dust and fragments thousands of feet in the air. These two types of eruptions cause two different types of volcanic formations.

Slide #3

Here we have an example of the gentle flowing eruption. This tide of incandescent lava is advancing 500 feet per hour. Upon cooling, such lava forms gently sloping beds...

Slide #6

...such as seen here in these vast fields of sharp clinkers in Hawaii.

Slide #7

The explosive volcano, such as this one in the Azores, which burst from the ocean floor, throws its lava and cinders thousands of feet in the air. As these cinders and ashes settle back to earth, they form the characteristic cone of the explosive volcano...

SUPPLEMENTARY MATERIALS (continued)

Slide #8 ...such as we see here: regular, almost symmetrical, steep sides. Another feature of the explosive type volcano is the unexpected.

Slide #9 Here, only a few days after the initial explosion, the volcano has cooled, quieted, and sunk beneath the sea again. But we are not fooled by the tranquility of this scene. For, in just two short days, this volcano violently belched forth again with renewed fury.

Volcanoes usually have only brief periods of activity. When the built-up pressure has been relieved by eruption, the lava flow slows, cools, and stops. It forms a plug of solidified rock in the vent. A dormant state follows and all is quiet until the pent-up pressure builds again to the eruption point.

Interesting related phenomena:

Slide #10 Most people have a mental picture of volcanoes as being fire and smoke. Here, close to the vent of an Hawaiian volcano, we can see that the fire is actually made of molten rock and glowing hot gasses. Shooting hundreds, even thousands, of feet in the air, this molten rock and dust cool and darken, becoming the "smoke" of a volcano. And, in some cases, as we have seen, volcanoes arise from under water.

SUPPLEMENTARY MATERIALS (continued)

Slide #11

A great deal of this "smoke" is actually steam. Although lava is mainly basalt, it takes on many different forms as it cools. It may form the light fluffy pumice or the heavy glass-like obsidian. Its final form depends on its gas content and temperature when it is ejected into the air.

Will science ever be able to predict volcances? Though such a possibility may seem improbable, there is good reason to be optimistic. We have already pointed out the fact that volcanoes are related somehow to earthquakes. When more is known of this relationship, volcanoes may well be predicted from earth movements. Also, scientists have noted a complex and not well-understood relationship between volcanoes and sunspots.

Volcanic eruptions may have widespread effects. Volcano "fallout" ruins crops and farmland miles from the greatest reach of flowing lava. Also, the dust that remains airborne for a time has its effect.

The clouding of the earth's atmosphere by the dust of the 1912 eruption of Mt. Katmai, in Alaska, caused a measurable blocking of solar radiation. A full 20% of the sun's radiation was blocked at noon. Such a blocking

SUPPLEMENTARY MATERIALS (continued)

effect, continued long enough, could lower the earth's temperature 13 degrees. This in turn would cause year around ice conditions in much of the Temperate Zones. Following this line of reasoning, some theorists believe that glacial periods follow periods of extreme volcanic activity.

Review questions:

1. Where do volcanoes occur most frequently?
2. What natural phenomena have been found to be related to volcanic activity?
3. What two types of volcanic eruption (and lava flow) occur and what kinds of formations does each cause?
4. What are the "smoke" and "fire" of a volcano?
5. How do volcanoes cause crop damage even beyond the reach of lava flow?
6. How could a single explosive eruption have round-the-world effects?
7. What is the theoretical relationship between volcanic activity and the "ice ages"?

B. Other titles:

1. Recent Adventures in Science
2. Modern Medical Miracles
3. Evolution, Man and Culture

III. Individual Study Units

A. Examples: Microscopic Study of Human Tissue

SUPPLEMENTARY MATERIALS (continued)

Introduction

Protozoa are one-celled animals. Metazoa are many-celled animals. This unit is a study of a metazoan, the human being.

The cells of metazoans are grouped according to type of structure, and function. Such groups of similar cells are called tissues.

In the human being, as in other metazoans, cells can be grouped into two general groups: 1) somatic or body cells; and 2) germ or sex cells.

In this microscope study unit, you will examine the four types of somatic tissue. They are:

1. Epithelial tissues are coverings. The skin and scalp are exterior coverings. The lining of the digestive tract and the covering of the tongue are interior covering tissues.
2. Connective or supporting tissues serve to bind the body together and support it. Both bone and blood cells are in this group.
3. Muscular or contractile tissues are the tissues that move the body or its parts. Arm and leg muscles as well as the heart and diaphragm are contractile tissues.
4. Nervous tissue is made of special cells that can receive, store, or transmit sensations or information within the body. Taste buds, the retina of the eye, brain cells, and nerve cells are all considered parts of the nervous tissue.

Microscope Exercise:

Study under the microscope the following tissue slides:

1. Epithelial tissues: the human scalp
   a. View the human scalp slide under the microscope and sketch

SUPPLEMENTARY MATERIALS (continued)

what you see.

b. Using a standard reference, label as many parts of the scalp as you can.

2. Connective tissue: human blood and bone

a. View the human blood slide on the microscope and sketch what you see.

b. Using a standard reference, identify the parts of the human blood and label them.

c. Do the same with the human bone slides.

3. Nervous tissue: human taste buds

a. View the slide of the human tongue on the microscope and sketch what you see.

b. Using a standard reference, identify and label the parts of the human tongue.

c. The taste buds are nervous tissue cells. What *other kind* of tissue is in the human tongue?

Questions:

1. What are groups of similar cells called in Metazoa?
2. What are the two basic kinds of cells?
3. What are the four kinds of somatic tissues?
4. What is the primary function of each kind of somatic tissue?
5. Blood and bone cells represent what kind of tissue?
6. What is another relationship between blood and bone?
7. What kind of tissue is the human scalp?
8. What kinds of tissue are in the human tongue?

SUPPLEMENTARY MATERIALS (continued)

9. What kind of tissue was not studied on the microscope?

10. Name four representative contractile tissues.

IV. Resource Units

A. Example: Underwater Exploration Unit

1. What are some of the practical and scientific reasons for underwater explorations?

a. "We race for the ocean's secrets."

Life: Dec. 21, '62, p. 40-58

b. "Frogmen in Antarctica."

Newsweek: June 9, '58, p. 77

c. "Four years of driving to the bottom of the sea."

Nat'l Geographic: May '58, p. 715

d. "France's fabulous frogmen."

Reader's Digest: Dec. '59, p. 137

2. What are some of the problems (and dangers) of underwater exploration and how are they handled?

a. "To skin dive and survive."

Newsweek: July 4, '60, p. 78

b. "Death and I at 60 fathoms."

Sat. Eve. Post: Mar. 22, '58, p. 38

c. "Physician outlines skin-diving hazards."

Science Digest: Mar. '57, p. 51

d. "Deepest dive ever made."

Life: Aug. 4, '61, p.66

e. "Amateur divers advised to wear porous suits."

Science News Letter: Sept. 9, '61, p. 164

SUPPLEMENTARY MATERIALS (continued)

f. "We hunted sharks and sunken gold."

Sat. Eve. Post: Mar. 1, '58, p. 32

3. Who are some of the outstanding underwater scientists and explorers?

a. "Conquering the bends."

Newsweek: Dec. 19, '60, p. 66

b. "From research to search."

Newsweek: Apr. 22, '63, p. 27

c. "Long deep dive."

Nat'l Geographic: May '63, p. 718

4. What is some of the equipment man has developed for underwater exploration?

a. "Sportsmen in the deep."

Newsweek: Aug. 11, '58, p. 79

b. "Race for the bottom of the sea."

Popular Science: July '63, p. 35

c. "Diving saucer takes to the deep."

Nat'l Geographic: April, '60, p. 570

d. "How deep is the ocean?"

Newsweek: Aug. 11, '58, p. 76

5. What are the advantages and disadvantages of the bathyscaphe?

a. "Bathyscaphe explores ocean bottom."

Science News Letter: Jan. 18, '58, p. 35

b. "Four years of diving to the bottom of the sea."

Nat'l Geographic: May '58, p. 715

SUPPLEMENTARY MATERIALS (continued)

c. "How deep is the ocean."

Newsweek: Aug. 11, '58, p. 76

6. What does the "underwater camp" proposed by scientist Link offer underwater explorations?

a. "Our man-in-sea project."

Nat'l Geographic: May '63, p. 712

b. "Long deep dive."

Nat'l Geographic: May '63, p. 718

c. "Race for the bottom of the sea."

Popular Science: July '63, p. 35

7. What are some of the contributions to anthropology and archeology made by underwater explorations?

a. "Archeologists in aqualungs."

Scientific American: Sept. '61, p. 92

b. "Did cavemen live in Florida 80 centuries before Christ?"

Popular Science: May '61, p. 64

c. "Ghost from the depths."

Nat'l Geographic: Jan. '62, p. 42

d. "Sea search into history at Caesarea."

Life: May 5, '61, p. 72

e. "Exploring the drowned city of Port Royal."

Nat'l Geographic: Feb. '60, p. 151

f. "Oldest known shipwreck yields bronze age cargo."

Nat'l Geographic: May '62, p. 696

g. "Dzibilchaltun: up from the well of time."

Nat'l Geographic: Jan. '59, p. 110

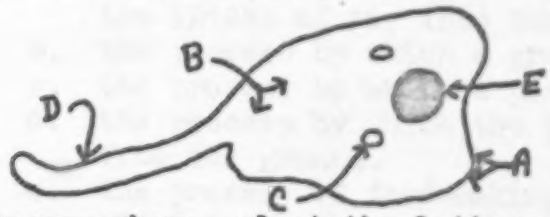
Appendix C

Evaluation Instrument Used for Achievement Measure

Evaluation Instrument
(PL II - Project)
GENERAL SCIENCE

PART A

The diagram below refers to questions 1 through 3.



From the diagram above select the letters which indicate the part of the cell labeled in 1, 2, and 3.

1. Cytoplasm.

2. Pseudopod.

3. Cell membrane.

4. The tiny body that looks like a nucleus inside a nucleus is called:
   a. nucleoplasm
   b. chromatin
   c. nuclear body
   d. nuclear membrane
   e. nucleolus

5. Eggs are produced in the:
   a. cloaca
   b. oviducts
   c. ovaries
   d. gonads
   e. testes

6. Which is the best description of protoplasm?
   a. The organic, living material in cells.
   b. Tiny openings which materials enter and leave the cell through.
   c. The cavities used to store food until the cell uses it.
   d. The living things floating around in the cytoplasm.
   e. The casing which surrounds cell material.

7. Why is the nucleus such an important part of the cell?
   a. Because it has nucleoli in it.
   b. Because there is only one nucleus to a cell.
   c. It takes up most of the space within the cell.
   d. Most of the activity of a cell goes on in the nucleus.
   e. It controls cell activity and reproduction.

GENERAL SCIENCE: PART A (continued)

8. The seeds of a fruit are formed from:
   a. filament
   b. style
   c. petals
   d. pollen
   e. sepals

9. Photosynthesis is:
   a. the process which opens and closes the stomates to regulate the intake of air into the leaf.
   b. the process by which a green plant reproduces itself.
   c. the process by which a plant develops its color.
   d. the process by which the plant collects water and minerals from the ground.
   e. the process of food-making in a green plant which takes place in the leaves.

10. Water and minerals are taken into green plants through:
   a. the phloem
   b. roots
   c. the stem
   d. the xylem tubes
   e. stomates

11. If a pea plant with genes TT was mated with another pea plant with genes Tt the offspring would be:
   a. $\frac{1}{2}$ purebred tall - $\frac{1}{2}$ hybrid tall
   b. $\frac{1}{2}$ purebred tall - $\frac{1}{2}$ hybrid and $\frac{1}{2}$ purebred short
   c. $\frac{1}{2}$ hybrid - $\frac{1}{2}$ purebred tall and $\frac{1}{2}$ purebred short
   d. $\frac{1}{2}$ purebred short - $\frac{1}{2}$ purebred tall and $\frac{1}{2}$ hybrid
   e. none of these

12. Most types of animals reproduce:
   a. by binary fission
   b. sexually
   c. asexually
   d. by budding
   e. by spores

13. A pupil was studying drawings of five types of cells: muscle cells, blood cells, wood cells, leaf cells, and nerve cells. The cell with the heaviest cell wall is most likely to be the:
   a. muscle cell
   b. blood cell
   c. wood cell
   d. leaf cell
   e. nerve cell

GENERAL SCIENCE: PART A (continued)

14. Which of the following is the best description of inclusion?
    a. granules and rods found in animal cells.
    b. chloroplasts
    c. found inside the vacuoles
    d. a non-living particle found inside a cell
    e. food vacuoles

15. The best definition of a system is:
    a. a group of organs involved in the same function.
    b. a group of cells that perform a similar function.
    c. a group of tissues involved in the same function.
    d. a group of organs found only in plants.
    e. a group of cells found only in animals.

16. The expression $6\ CO_2 + 6\ H_2O \longrightarrow C_6H_{12}O_6 + 6\ O_2$ can best be interpreted as indicating that:
    a. six molecules of carbon dioxide combine with six molecules of water to yield six carbohydrate molecules and six molecules of oxygen.
    b. six molecules of carbon monoxide combine with six molecules of water to yield six molecules of oxygen.
    c. six molecules of carbon dioxide combine with six molecules of water to yield one molecule of starch and six molecules of oxygen.
    d. six molecules of carbon dioxide combine with six molecules of water to yield one molecule of sugar and six molecules of oxygen.
    e. six molecules of carbon monoxide combine with six molecules of water to yield six molecules of sugar and six molecules of oxygen.

17. Life on earth could not exist without green plants because:
    a. they maintain the fitness of the earth's atmosphere.
    b. they convert carbon dioxide to oxygen.
    c. through photosynthesis they produce oxygen.
    d. all of the above.
    e. none of the above.

18. The plastids that give plants their green color are called:
    a. nucleoplasts.
    b. cytoplasts.
    c. chromoplasts.
    d. chloroplasts.
    e. mitoplasts.

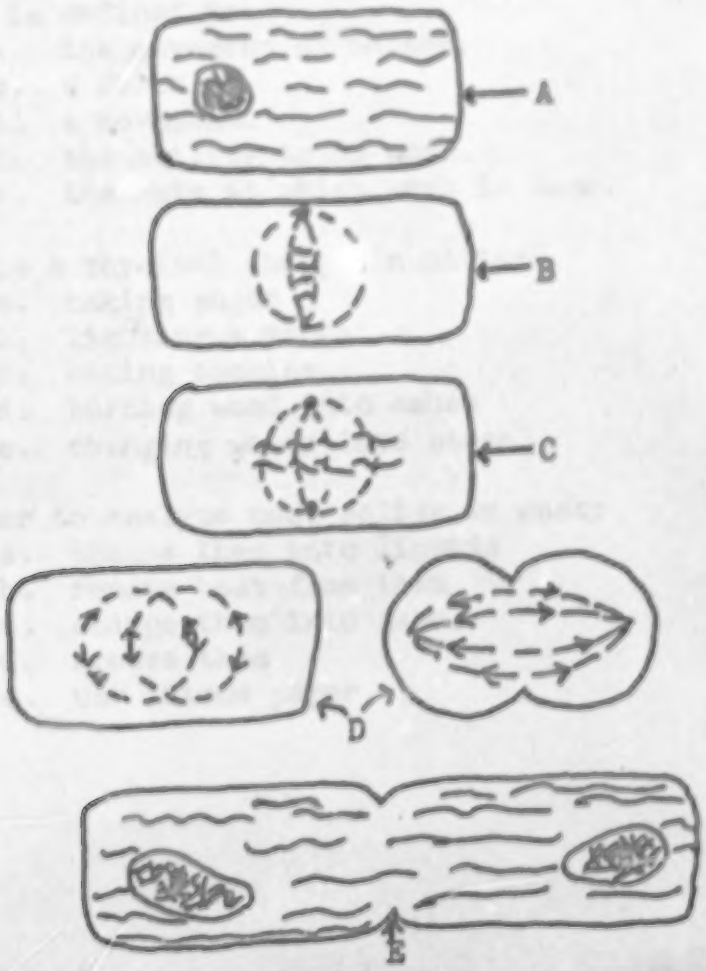
GENERAL SCIENCE: PART A (continued)

19. In the classification of living organisms the two major divisions are the plant and animal kingdoms. Which one of the following listings show the proper order of the other divisions?
    a. phylum, class, order, genus, family, species.
    b. phylum, class, order, family, genus, species.
    c. phylum, family, order, genus, species, class.
    d. phylum, class, order, family, species, genus.
    e. family, phylum, class, order, genus, species.

20. A fertilized egg is called:
    a. a zygote.
    b. an embryo.
    c. an ovule.
    d. a sperm.
    e. a cloaca.

21. If both parents have blue eyes you will most probably have blue eyes. This is because two _____ traits have been combined.
    a. mutated.
    b. regenerated.
    c. recessive.
    d. biological.
    e. dominant.

22, 23, and 24 below describe some phase in cell activity pictured in the drawings below. For each description select the drawing that it describes.



GENERAL SCIENCE: PART A (continued)

22. Anaphase.

23. Interphase.

24. Prophase.

25. The states of matter are:
    a. solid and liquid.
    b. solid and chemical.
    c. liquid and chemical.
    d. solid, liquid, and chemical.
    e. solid, liquid, and gas.

26. When coal burns, _____ energy is changed into _____ energy.
    a. heat to electrical
    b. heat to mechanical
    c. chemical to electrical
    d. chemical to mechanical
    e. chemical to heat

27. The number of electrons an atom can borrow or lend is called its:
    a. electron reaction.
    b. electron count.
    c. valence reaction.
    d. valence.
    e. none of these

28. Energy is defined as:
    a. the movement of matter.
    b. a force.
    c. a movement.
    d. the ability to do work.
    e. the rate at which work is done.

29. Which is a physical change in matter?
    a. making sugar
    b. lighting a match
    c. baking cookies
    d. burning wood into ashes
    e. changing water into steam

30. In order to analyze most solids we must:
    a. change them into liquids
    b. remove heat from them
    c. change them into gases
    d. freeze them
    e. use litmus paper

GENERAL SCIENCE: PART A (continued)

31. Atoms can help each other fission. This is called:
    a. chaining.
    b. fission.
    c. fusion.
    d. catylistation.
    e. chain reaction.

32. An equation is a short way of writing about a chemical:
    a. molecule.
    b. atom.
    c. reagent.
    d. reaction.
    e. reconstruction.

33. Atoms with a different atomic weight than most of the atoms in that element are:
    a. ions.
    b. isotopes.
    c. electronic.
    d. neutral.
    e. none of the above

34. The rate of radioactive decay is called:
    a. the decay period.
    b. the radioactive period.
    c. the life period.
    d. the half-life period.
    e. none of the above

35. CO_2 shows:
    a. 1 part carbon and 2 parts oxygen
    b. 2 parts carbon and 2 parts oxygen
    c. an atom of carbon and an atom of oxygen
    d. 1 part carbon and 1 part oxygen
    e. none of the above

36. Which of these equations is not balanced?
    a. $H_2 + O \longrightarrow H_2O$
    b. $C_2 + O_4 \longrightarrow C_2O_4$
    c. $H_2SO_4 + Cu \longrightarrow H + CuSO_4$
    d. $HCl + Cu \longrightarrow H + CuCl$
    e. $Na_2SO_4 \longrightarrow Na_2 + S + O_4$

GENERAL SCIENCE: PART A (continued)

37. If a candle is lit and then a bottle is inverted so that the candle is covered by the bottle, the candle will burn for a little while and then go out. The reason for this is that:
    a. it is too hot in the bottle.
    b. the air contains hydrogen.
    c. the O_2 needed for combustion is used up.
    d. the nitrogen needed for combustion is used up.
    e. the hydrogen is used up.

38. Litmus paper was placed into a chemical compound; the paper turned red. The compound was:
    a. an acid.
    b. a base.
    c. neutral.
    d. a metal.
    e. hydrogen peroxide.

39. The amount of radioactivity in a certain area is called:
    a. the fissionable count.
    b. the Geiger count.
    c. the radiation count.
    d. the particle count.
    e. the alpha, beta, gamma count.

40.

The figure above is a(n):
    a. wide-mouthed bottle.
    b. Reagent bottle.
    c. beaker.
    d. Erlenmeyer flask.
    e. Florence flask.

41. Matter which cannot be further simplified by ordinary chemical means is:
    a. a molecule.
    b. an element.
    c. a compound.
    d. gamma particles.
    e. positrons.

For questions 42 and 43 refer to the following diagram.

GENERAL SCIENCE: PART A (continued)

42. The atomic weight of this atom is:
    a. 4
    b. 3
    c. 7
    d. 5
    e. 12

43. The number of _____ in the nucleus is equal to the number of _____ in the planetary rings outside of the nucleus.
    a. protons - electrons
    b. electrons - protons
    c. protons - neutrons
    d. neutrons - electrons
    e. electrons - neutrons

44. If you simplify a compound to its smallest division you will have:
    a. an element.
    b. a proton.
    c. an atom.
    d. a molecule.
    e. an electron.

45. Which of the following is true about forming compounds with metals and non-metals?
    a. Both must have plus valences.
    b. Both must have minus valences.
    c. Metal must have a plus valence,
       non-metal a minus valence.
    d. Metal must have a minus valence,
       non-metal a plus valence.
    e. none of the above

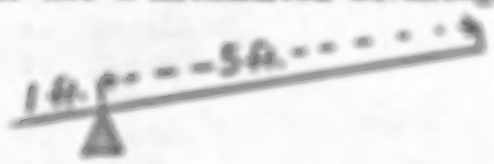
46. "Work" is best described as:
    a. a force.
    b. a movement.
    c. movement of matter.
    d. use of a force to move something a certain distance.
    e. a force moved horizontally.

47. If a force of 10 lb is used to lift an object 10 ft, _____ of work is done.
    a. 10 lb.
    b. 10 ft-lb.
    c. 1 ft-lb.
    d. 100 lb.
    e. 100 ft-lb.

GENERAL SCIENCE: PART A (continued)

48. One horsepower is equal to:
    a. 550 ft-lb.
    b. 550 ft-lb per second.
    c. 550 ft-lb per minute.
    d. 550 ft-lb per hour.
    e. 550 ft-lb per hour ÷ 60.

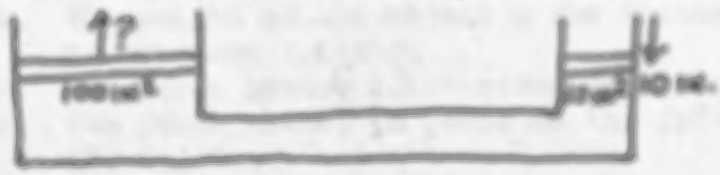
49. A lever has a mechanical advantage of:



    a. 1
    b. 2
    c. 3
    d. 4
    e. 5

50. The efficiency of a particular machine is:
    a. the input.
    b. the output.
    c. $\frac{\text{input}}{\text{output}}$
    d. $\frac{\text{output}}{\text{input}}$
    e. output X input

51. If the 10 square-inch piston in the pictured hydraulic machine is pushed down 10 inches, the 100 square-inch piston will rise:



    a. 1 inch.
    b. 2 inches.
    c. 3 inches.
    d. 4 inches.
    e. 10 inches.

52. Two cars traveling in the same direction at 35 miles per hour relative to a tree are traveling:
    a. 35 mph relative to each other.
    b. 0 mph relative to each other.
    c. 70 mph relative to each other.
    d. 35/35 mph relative to each other.
    e. 70/35 mph relative to each other.

GENERAL SCIENCE: PART A (continued)

53. Archimedes' Law states that:
    a. a floating object will continue to float.
    b. a floating object will displace equal to its own weight.
    c. a floating object will displace equal to its own volume.
    d. a floating object will not displace at all.
    e. a floating object will eventually sink.

54. Which type of engine best illustrates Newton's third law of motion?
    a. gasoline.
    b. diesel.
    c. jet.
    d. steam.
    e. wind.

55. What is the firing order in a four-cycle engine?
    a. intake, power, compression, exhaust.
    b. power, intake, compression, exhaust.
    c. compression, power, intake, exhaust.
    d. intake, compression, exhaust, power.
    e. intake, compression, power, exhaust.

56. 1650 lb can be moved 2 ft in one second by a _____ horsepower engine.
    a. 1
    b. 2
    c. 4
    d. 6
    e. 8

57. The amount of work done when something is pushed across a level floor is:
    a. the weight of the object x distance pushed.
    b. the weight of the object x the distance pushed + the work needed to overcome friction.
    c. the force needed to overcome friction.
    d. the force needed to overcome the friction x the weight of the object.
    e. the force needed to overcome the friction x the distance pushed.

58. An object with its center of gravity near the bottom is:
    a. less stable than an object with the center of gravity at the top.
    b. just as stable as an object with the center of gravity at the top.
    c. more stable than an object with the center of gravity at the top.
    d. less stable than an object with the center of gravity near the middle.
    e. not stable at all.

GENERAL SCIENCE: PART A (continued)

59. If there were no force of gravity, objects would have no:
    a. weight.
    b. mass.
    c. energy.
    d. volume.
    e. velocity.

60. The rate of doing work is called:
    a. foot-pound.
    b. force.
    c. speed.
    d. mechanical advantage.
    e. power.

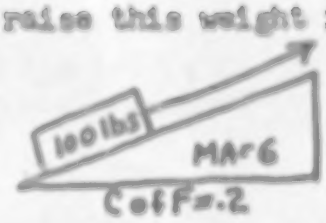
61. The fulcrum for this pair of tongs is:
    a. A
    b. B
    c. C
    d. D
    e. A and B together.

62. The mechanical advantage of the compound machine below is:

    a. 3/5
    b. 5/3
    c. 5
    d. 15
    e. 15 3/3

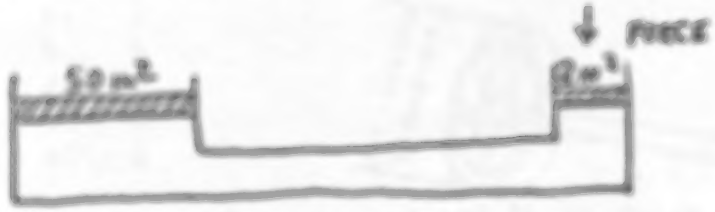
63. A machine has a mechanical advantage of 5. It produces 10 foot-pounds of work for each 8 pounds of force used. Its efficiency is:
    a. 80%
    b. 75%
    c. 50%
    d. 25%
    e. 20%

64. The extra force needed to raise this weight is:
    a. 20 lb.
    b. 30 lb.
    c. 40 lb.
    d. 50 lb.
    e. 60 lb.



GENERAL SCIENCES: PART A (continued)

65. The mechanical advantage of this hydraulic machine is:



a. 25
b. 100
c. 50
d. 1/25
e. .005

66. The center of gravity of an object's weight is:
a. a point halfway between the ends of the object.
b. a point halfway through the width of the object.
c. the point at which the object can be balanced.
d. a combination of a and b above.
e. a, b, and c.

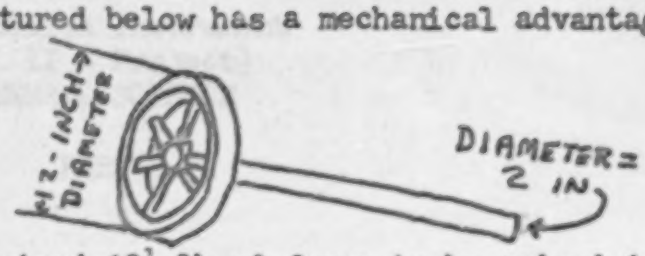
67. A strong man and a weak man lift equal weights equal distances. The strong man does:
a. much less work.
b. a little less work.
c. the same amount of work.
d. a little more work.
e. none of the above.

68. Centrifugal and centripetal force affect:
a. all objects.
b. all moving objects.
c. all objects moving in a straight line.
d. all objects moving in a curved path.
e. all objects at rest.

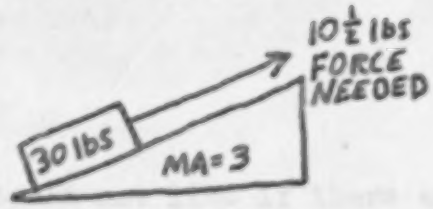
69. A car with a mass of 100 mass units is moving with a velocity of 100 ft/sec. The momentum of the car is:
a. 100/100 = 1 momentum unit.
b. 100 x 100 = 10,000 momentum units.
c. 100 x 1 = 100 momentum units.
d. 10,000/ 10 = 1,000 momentum units.
e. none of the above.

GENERAL SCIENCE: PART A (continued)

70. The wheel and axle pictured below has a mechanical advantage of:
    a. 2
    b. 4
    c. 10
    d. 8
    e. 6



71. The 30 lb actually required 10½ lb of force to be raised 1 ft by this inclined plane. Therefore the actual foot-pounds of work done equal:



    a. 30 foot-pounds.
    b. 1 ½ foot-pounds.
    c. 28 ½ foot-pounds.
    d. 31 ½ foot-pounds.
    e. 30 ½ foot-pounds.

72. A car traveled 200 miles in 5 hours. The average speed of the car was:
    a. 1000 mph.
    b. 200 mph.
    c. 5 mph.
    d. 5/200 mph.
    e. 200/5 or 40 mph.

73. In the metric system the meter is the unit of measurement for:
    a. weight.
    b. mass.
    c. volume.
    d. length.
    e. temperature.

74. Centi- is a prefix meaning:
    a. 1/100.
    b. 100.
    c. 1/1000.
    d. 1000
    e. 10.

75. What would be the correct measure of the volume of a cube 3 in.x 3 in.?
    a. 3 cu in.
    b. 3 cu ft.
    c. 6 cu in.
    d. 27 cu in.
    e. 9 cu in.

Evaluation Instrument
(PL II - Project)
GENERAL SCIENCE

PART B

76. The time required for the earth to revolve around the sun is:
    a. 12 hours.
    b. 24 hours.
    c. 28 days.
    d. 30 or 31 days.
    e. 365 $\frac{1}{4}$ days.

77. One of the reasons why we could not live if there were no atmosphere covering the earth is that:
    a. it would be too cold all day (24 hours).
    b. it would be too hot all day (24 hours).
    c. it would be too cold at night.
    d. it would be too hot during daytime.
    e. both c and d.

78. The atmosphere may be best described as:
    a. a shield.
    b. a pane of glass.
    c. a reflector.
    d. an absorbant.
    e. a wall of air.

79. The process by which a cloud droplet develops to a size large enough to fall is called:
    a. precipitation.
    b. dew point.
    c. saturation.
    d. coalescence.
    e. condensation.

80. On December 22, the North Pole has:
    a. 18 hours of day and 6 hours of night.
    b. 6 hours of day and 18 hours of night.
    c. 12 hours of day and 12 hours of night.
    d. 24 hours of day.
    e. 24 hours of night.

GENERAL SCIENCE: PART B (continued)

81. Which of the following is true?
    a. Air flows from low pressure to high pressure.
    b. Lows form almost entirely over the cool oceans.
    c. Air flows from high pressure to low pressure.
    d. In the prevailing westerlies highs and lows generally travel in a westerly direction.
    e. None of the above

82. High pressure cells (highs) generally:
    a. have no effect on the weather.
    b. have little effect on the weather.
    c. bring fair weather.
    d. bring unsettled weather.
    e. destroy crops through pressure.

83. A vast body of air (often as large as hundreds of thousands of square miles) in which the conditions of temperature and moisture are much the same throughout, is called a(n):
    a. front.
    b. squall line.
    c. doldrum.
    d. air mass.
    e. land mass.

84. The most violent storms which form over land and are only a few hundred feet in diameter are called:
    a. thunderstorms.
    b. hurricanes.
    c. tornados.
    d. squalls.
    e. rainstorms.

85. The four conditions of the atmosphere are:
    a. heat, volume, wind, and moisture.
    b. heat, pressure, wind, and moisture.
    c. heat, pressure, wind, and volume.
    d. heat, pressure, volume, and moisture.
    e. pressure, volume, moisture, and wind.

86. The point at which beads of water form on the outside of a glass of ice is the:
    a. humidity coefficient.
    b. dew point.
    c. relative humidity.
    d. freezing point.
    e. humidity point.

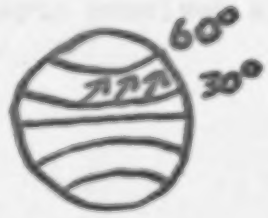
GENERAL SCIENCE: PART B (continued)

88. Puffy, cotton-like clouds are called _____ clouds.
    a. towering
    b. high
    c. cumulus
    d. cirrus
    e. stratus

89. If the air contains 60% of the water it <u>can</u> hold, we say that its relative humidity is:
    a. 60%
    b. 40%
    c. 100%
    d. 60% - 40%
    e. 100% - 60%

90. Clouds are made up of:
    a. either droplets of water or ice crystals.
    b. droplets of water only.
    c. ice crystals only.
    d. vapor and smoke.
    e. smoke only.

91. The winds pictured here are the:
    a. prevailing westerlies.
    b. easterlies or trade winds.
    c. polar easterlies.
    d. polar westerlies.
    e. northwest trades.



92. The two motions of the earth which affect its weather are:
    a. traveling with the solar system and its rotation.
    b. the trip around the sun and the earth's daily rotation.
    c. traveling with the solar system and its rotation with the rest of our galaxy.
    d. traveling with the solar system and its spinning.
    e. traveling opposite to the solar system and the trip around the sun.

93. The sun is in a gaseous form:
    a. because it is a member of the solar system.
    b. because it is the center of our solar system.
    c. because it is too hot to be either solid or liquid.
    d. because it is so far from earth.
    e. because it shines.

GENERAL SCIENCE: PART B (continued)

94. The largest known planet to astronomers is:
    a. Mars.
    b. Saturn.
    c. Mercury.
    d. Jupiter.
    e. Earth.

95. We can only see the corona, or circle around the sun, when:
    a. the earth passes between the sun and moon.
    b. the sun passes between the earth and moon.
    c. the moon passes between the sun and earth.
    d. the sun is bright.
    e. the sun is rising.

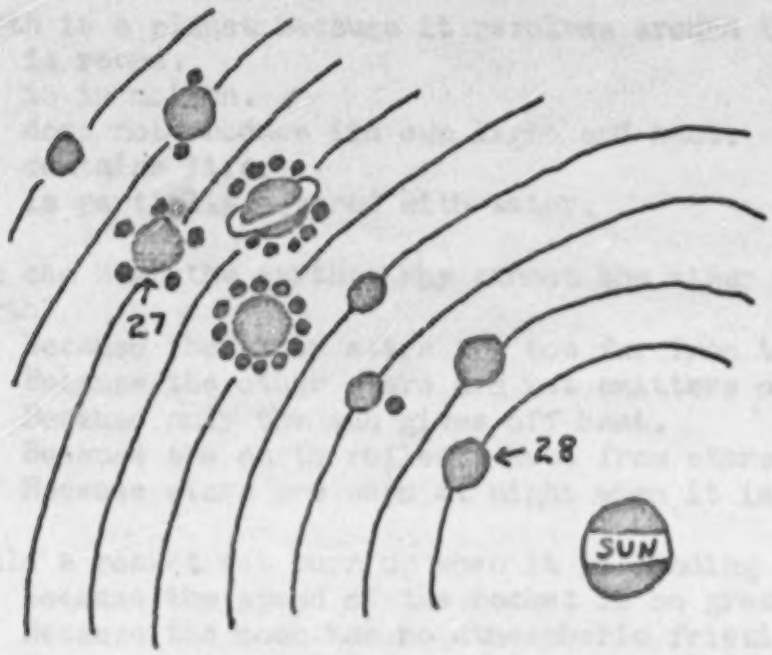
96. The basic principle underlying the occurrence of tides is:
    a. rotation.
    b. force of gravity.
    c. acceleration.
    d. inertia.
    e. momentum.

97. The astronomer(s) who decided that the earth revolved around the sun was/were:
    a. Kepler.
    b. the ancient Greeks.
    c. the Ancient Egyptians.
    d. Copernicus.
    e. Newton.

98. Why have we never seen the dark side of the moon?
    a. The moon rotates once for every revolution around the earth.
    b. The earth rotates at the same speed as the moon.
    c. The earth rotates faster than the moon.
    d. The moon does not rotate.
    e. The earth does not rotate.

Below is a diagram of the sun and planets:

GENERAL SCIENCE: PART B (continued)



99. The planet numbered 27 is:
    a. Venus.
    b. Earth.
    c. Mercury.
    d. Jupiter.
    e. Uranus.

100. The planet numbered 28 is:
    a. Earth.
    b. Venus
    c. Mercury.
    d. Jupiter.
    e. Saturn.

101. In which ring from the sun is the planet Saturn found?
    a. second
    b. fourth
    c. sixth
    d. seventh
    e. eighth

102. The planet which has rings around it is:
    a. Neptune.
    b. Saturn.
    c. Venus.
    d. Mars.
    e. Jupiter.

GENERAL SCIENCE: PART B (continued)

103.. The earth is a planet because it revolves around the sun and:
a. is round.
b. is in motion.
c. does not produce its own light and heat.
d. contains life.
e. is partially covered with water.

104. The sun can heat the earth. Why cannot the other stars also heat the earth?
a. Because the other stars are too far from the earth.
b. Because the other stars are not emitters of heat.
c. Because only the sun gives off heat.
d. Because the earth reflects heat from stars.
e. Because stars are seen at night when it is cold.

105. Why would a rocket not burn up when it is landing on the moon?
a. Because the speed of the rocket is so great.
b. Because the moon has no atmospheric friction.
c. Because the moon's gravitation prevents this.
d. Because rockets are resistant to burning up.
e. Because the atmosphere of the moon contains inert gases preventing burning.

106. The stars one would use if he wanted to find the North star are called:
a. pointer stars.
b. stars of Cassiopeiae.
c. stars of Ursa Minor.
d. Casper and Pollux.
e. handle stars.

107. When one sees a group of stars he is seeing a:
a. comet trail system.
b. solar system.
c. constellation.
d. orbit.
e. universe.

108. If x is the phenomenon which causes the earth to stay in orbit then y is the phenomenon which causes our planet to move along its path. This is called:
a. conductance.
b. velocity.
c. gravitation.
d. inertia.
e. solar attraction.

GENERAL SCIENCE: PART B (continued)

109. X is the physical force which keeps the earth in its orbit. This is:
   a. revolution.
   b. inertia.
   c. magnetism.
   d. gravity.
   e. electrical repulsion.

110. If we were to look at the night sky we would notice that stars were of different colors. Astronomers believe that this difference is due to the:
   a. difference in the earth's axis angle.
   b. difference in temperature of the stars.
   c. difference in size of the stars.
   d. difference in angle from the earth.
   e. difference in amount of light years.

111. To determine the latitude of a point on earth:
   a. measure the angle made by a line from this point to Polaris and from you to the horizon.
   b. measure the angle made by a line from this point to the center of the earth and from the center of the earth to the equator.
   c. measure the angle made by a line from this point to the center of the earth and from the center of the earth to Greenwich.
   d. measure the angle made by a line from this point to Greenwich and from Greenwich to the equator.
   e. measure the angle made by a line from this point to Polaris and from Polaris to the equator.

112. The statement "Sound can travel through a vacuum." is:
   a. absolutely true.
   b. probably true.
   c. probably false.
   d. absolutely false.
   e. depends on the intensity.

113. Which of the following is the correct order for sound transmission? From the eardrum to:
   a. hammer, anvil, and stirrup.
   b. stirrup, anvil, and hammer.
   c. hammer, anvil, and cochlea.
   d. stirrup, cochlea, and anvil.
   e. anvil, stirrup, and cochlea.

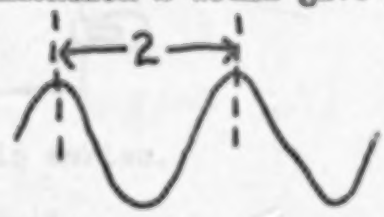
114. The speed of sound depends:
   a. on the density of the medium.
   b. on the quality of the pitch.
   c. on the quality of the vibration.
   d. on the density of the vibration.
   e. on the quality of the sound wave.

GENERAL SCIENCE: PART B (continued)

115. The change in the density of the air surrounding the source of sound is called:
    a. compression and vibration.
    b. compression and rarefaction.
    c. rarefaction and expansion.
    d. rarefaction and vibration.
    e. expansion and vibration.

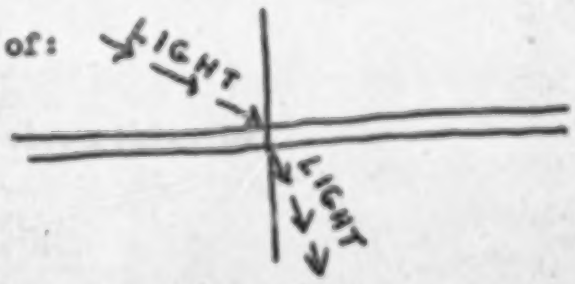
116. Before we "hear" a sound, the sound waves must be transmitted from the various parts of the ear to:
    a. the brain which interprets the sound.
    b. the auditory nerve which interprets the sound.
    c. the cochlea which intreprets the sound.
    d. the auditory nerve which reproduces the sound.
    e. the brain which reproduces the sound.

117. In measuring a sound wave, dimension 2 would give you:
    a. pitch.
    b. quality.
    c. amplitude.
    d. frequency.
    e. wavelength.

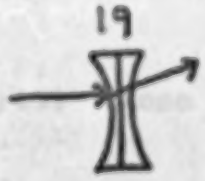


118. Heating a small object until it is red-hot produces _____ light.
    a. transparent
    b. translucent
    c. opaque
    d. incandescent
    e. flourescent

119. The figure below is an example of:
    a. refraction.
    b. reflection.
    c. dispersion.
    d. diffraction.
    e. none of the above



120. Figure 19 is a(n):
    a. concave lens.
    b. convex lens.
    c. concave mirror.
    d. convex mirror.
    e. semi-concave lens.



121. The nearsighted eye focuses:
    a. in back of the retina.
    b. in front of the lens.
    c. in front of the retina.
    d. on the retina.
    e. on the lens.

GENERAL SCIENCE: PART B (continued)

Below is a drawing of an eye. Match the following parts with the correct letter.

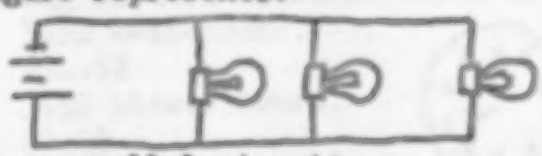
122. Cornea ( )

123. Optic nerve ( )

124. Lens ( )

125. A shadow is produced when light is blocked by a(n) _____ object.
   a. transparent.
   b. translucent
   c. opaque
   d. incandescent
   e. flourescent

126. This figure represents:



   a. a parallel circuit.
   b. batteries connected in series.
   c. a short circuit.
   d. a low-resistance circuit.
   e. a circuit with high resistance.

127. Molecules in an unmagnetized iron bar are:
   a. hot.
   b. cool.
   c. irregularly arranged.
   d. irregularly weighted.
   e. none of the above

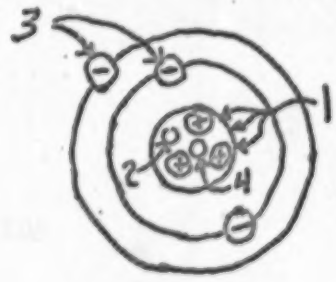
128. Both dry and wet cells produce electricity by:
   a. use of magnets.
   b. friction.
   c. chemical action.
   d. use of motors.
   e. use of an armature.

129. An induction motor has two parts. These are:
   a. commutator and magnet.
   b. stator and commutator.
   c. stator and rotor.
   d. rotor and commutator.
   e. generator and stator.

GENERAL SCIENCE: PART B (continued)

Here is a diagram of an atom. Label the parts from the following list.

A. electron
B. photon
C. neutron
D. nucleus
E. proton



130. Number 1 is ____.

131. Number 2 is ____.

132. Number 3 is ____.

133. Number 4 is ____.

134. The reading on this electric meter is:
a. 3452 watt-hours.
b. $34.52
c. 3452 linear hours.
d. $3.42
e. 3452 kilowatt-hours.

135. Static electricity is:
a. electricity at rest.
b. electricity in motion.
c. produced by a battery.
d. magnetic force.
e. an electromagnet.

136. Two or more voltaic cells connected together form:
a. a battery.
b. a motor.
c. an electrolyte.
d. a dry cell.
e. an electromagnet.

137. A conductor is a substance which:
a. offers a great amount of resistance.
b. prevents you from being shocked.
c. measures voltage.
d. acts as a fuel.
e. transmits electrical current.

138. Electric current is:
a. a flow of electrons along a conductor.
b. the amount of amperage.
c. electrical pressure divided by resistance.
d. static electricity.
e. positively charged.

GENERAL SCIENCE: PART B (continued)

139. In a dry cell a(n) _____ reacts with one of the conductors.
   a. wire
   b. armature
   c. liquid
   d. damp paste
   e. dry paste

140. Electromotive force is measured in:
   a. meters.
   b. kilowatt hours.
   c. volts.
   d. ohms.
   e. amperes.

141. Connecting cells in parallel:
   a. increase voltage.
   b. increase resistance.
   c. increase amperage.
   d. decrease amperage.
   e. decrease voltage.

142. The amount of current flowing through a circuit can be increased by:
   a. increasing the kilowatts.
   b. increasing the resistance.
   c. decreasing the resistance.
   d. decreasing the kilowatts.
   e. changing the circuit from parallel to series.

143. Electromotive force = 10 volts
rate of current flow = 2 amperes
resistance = ?
   a. 20 ohms
   b. 1/5 ohm
   c. 5 ohms
   d. 10 ohms
   e. 2 ohms

144. The numbers on the dial of a radio usually indicate:
   a. the range of broadcasting of the station.
   b. the location of the station.
   c. the frequency of the station.
   d. the type of program.
   e. the power of the station.

145. A teletype machine differs from a telegraph in that:
   a. it needs no wires.
   b. it needs no antenna.
   c. it needs no operator.
   d. it needs no person receiving.
   e. it needs no person sending.

GENERAL SCIENCE: PART B (continued)

146. Each AM radio station broadcasts a signal or wave of a certain frequency called the:
    a. carrier wave.
    b. rectifier wave.
    c. modulated wave.
    d. audio wave.
    e. pulsating wave.

147. FM broadcasts:
    a. have less static than AM.
    b. travel farther than AM.
    c. use sky waves.
    d. use a very low frequency.
    e. use amplitude modulation.

148. Another name for light-sensitive cells is:
    a. anode cells.
    b. photoelectric cells.
    c. photogenic cells.
    d. electrogenic cells.
    e. cathode cells.

149. Sound travels 1100 ft/sec, but a telephone transmits your voice much faster because:
    a. it uses rectifiers.
    b. it changes sound waves to light waves.
    c. it changes sound waves to electric waves.
    d. it modifies the frequency of sound waves.
    e. it uses microrelay.

150. The sound portion of television communication is broadcast in the same manner as:
    a. the teletype.
    b. the telegraph.
    c. the telephone.
    d. FM radio.
    e. AM radio.

Appendix D

Example of Unit Test Used for Grading Purposes

(Note: This is not a part of the formal evaluation of the study.)

Examples of Unit Tests Given in Project

BIOLOGY
UNIT I TEST

Name_____

1. Which is the living substance outside of the nucleus in a cell?
   a. cell wall
   b. cytoplasm
   c. vacuoles
   d. inclusions
   e. granules

2. The two main parts of protoplast are:
   a. the cytoplasm and the plasma membrane
   b. the nucleus and the vacuoles
   c. the cytoplasm and the nucleus
   d. the nucleus and the plasma membrane
   e. the cytoplasm and the vacuoles

3. How does protoplasm reproduce itself?
   a. by combining oxygen with food material within the cell
   b. through the process of hardening against the cell wall
   c. through tiny pores or openings in the plasma membrane
   d. through tiny pores or openings in the vacuolar membrane
   e. by division into small parts which grow again into full size

4. The cell wall is:
   a. a living structure made by the non-living protoplasm of plant cells
   b. a non-living structure made by the living protoplasm of plant cells
   c. a thin, living membrane which has tiny openings or pores through which materials enter and leave the cell
   d. all the protoplasm outside of the nucleus
   e. a membrane which controls movement in and out of a vacuole in the cytoplasm

5. What does the vacuole of a cell do?
   a. it stores food until the cell uses it
   b. it combines oxygen with food materials to produce heat energy
   c. it changes food material into cell structure
   d. it controls the movement of material in and out of the cell
   e. it does nothing at all that is useful to the cell

6. What do we call all of the living material in a cell?
   a. cytoplasm
   b. plasma membrane
   c. inclusions
   d. protoplast
   e. vacuoles

BIOLOGY: UNIT I TEST (continued)

7. What do we call all of the non-living material in a cell?
   a. cytoplasm
   b. plasma membrane
   c. inclusions
   d. protoplast
   e. vacuoles

8. Plastids are:
   a. non-living things floating in the cytoplasm
   b. living things floating in the cytoplasm
   c. both non-living and living things floating in the cytoplasm
   d. living things floating in the vacuoles
   e. non-living things attached to the cell walls

MATCHING

9. Chromoplasts	a. are found in the cells of flowers and fruits and contain yellow, orange and red pigments
10. Leucoplasts	b. contain a pigment called chlorophyll which makes leaves green
11. Chloroplasts	c. are colorless and usually serve as storage places of food for cells
	d. contain a pigment called chlorophyll which makes leaves yellow
	e. contain a pigment called chlorophyll which makes leaves green or orange

ESSAY

12. Who discovered cells?

13. How does protoplasm differ from an inclusion? What can it do that a non-living material cannot do?

14. Can protoplasm be made by man? Why or why not?

BIOLOGY: UNIT I TEST (continued)

15. What are vacuoles? What are they useful for and where are they found in a cell?

16. What do we call the living things floating around in the cytoplasm of a cell?

Appendix E

Questionnaire Used for Attitude Evaluation

PROGRAMMED TEXTBOOK ATTITUDE QUESTIONNAIRE

You have been using a programmed textbook for some time now, and probably have developed some opinions and feelings toward it. Since it would be very helpful to us to know about them, we have prepared this questionnaire which will give you a chance to express your opinions and feelings about this method of teaching.

Please read each statement carefully and tell us how you feel about it according to the following example. Be sure to answer each statement.

1. I think a programmed textbook is the greatest.

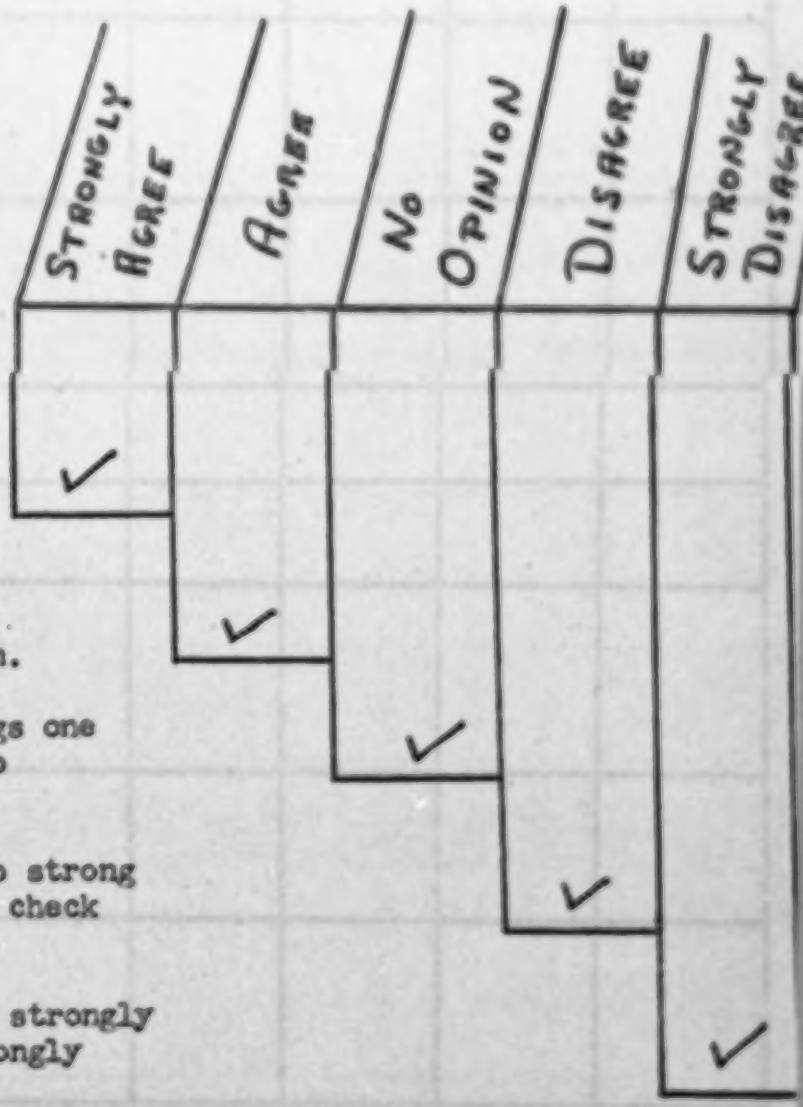
(If you agree with this statement strongly, put a check ( ) mark in the column labeled "Strongly agree."

On the other hand, if you simply agree but have no strong feelings about it, check the "Agree" column.

If you have no definite feelings one way or the other, check the "No Opinion" column.

If you disagree but have no strong feelings about the matter, check the "Disagree" column.

If you disagree and feel strongly about it, check the "Strongly Disagree" column.)



ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
1. I think using a programmed textbook is interesting....					
2. I think that learning from a programmed textbook is easier than learning from a regular textbook.....					
3. I think that I would learn better if I could skip writing down the answers to some of the frames in a programmed textbook.....					
4. I think I remember more of what I learn from a programmed textbook than when the teacher explains the subject to me.....					
5. I enjoy using a programmed textbook.....					
6. I think I remember more of what I learn from a programmed textbook..					
7. I lose interest in the subject when I have to write down the answer to every frame in a programmed textbook.....					
8. I dislike using a programmed textbook more than a regular textbook.....					
9. I think using a programmed textbook is more boring than having a teacher explain the subject to me.....					
10. I prefer having the teacher tell me how far I should work in a programmed textbook.....					

ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
11. I think I remember more of what I learn from a programmed textbook than from a regular textbook.....					
12. I think I learn quickly using a programmed textbook.....					
13. I have disliked a programmed textbook from the first time I began using it.....					
14. I think that learning from a programmed textbook is harder than learning from teacher explanations.....					
15. I think that writing the answers down to every frame in a programmed textbook helps me learn.....					
16. I enjoy using a programmed textbook more than a regular textbook.....					
17. I dislike using a programmed textbook.....					
18. I think that learning from a programmed textbook is easier than learning from teacher explanations.....					
19. I think that a programmed textbook does not repeat the same things too often.....					
20. I enjoy working on a programmed textbook for a full period every day.....					

ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
21. I gain confidence in my ability to learn as I work through a programed textbook.....					
22. I think I learn more from a programmed textbook than from a regular textbook.....					
23. I have less confidence in my ability to learn when using a programmed textbook than when a teacher explains the subject to me.....					
24. I think using a mask to cover up the answers in a programmed textbook is very clumsy.....					
25. I think that most of my classmates like programmed textbooks..					
26. I think I learn less from programmed textbooks than from regular textbooks.....					
27. I think I learn slowly using a programmed textbook.....					
28. I think using a mask to cover up the answers in a programmed textbook hinders my learning.....					
29. I have more confidence in my ability to learn when using a programmed textbook than when the teacher explains the subject to me.....					

ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
30. I think that writing down the answers to every frame in a programmed textbook hinders my learning.....					
31. I think that a programmed textbook should be worked on both during and outside class time.					
32. I lose confidence in my ability to learn as I work through a programmed textbook.....					
33. I think that a programmed textbook asks for the same answers too often.....					
34. I think I forget more of what I learn from a programmed textbook than when the teacher explains the subject to me.....					
35. I think using a programmed textbook is more boring than a regular textbook.....					
36. I think I learn more by using a programmed textbook.....					
37. I think that using a mask in a programmed textbook is unnecessary and should be eliminated.					
38. I think that most of my classmates dislike programmed textbooks.....					
39. I enjoy using a programmed textbook more than having the teacher explain the subject to me.....					

ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
40. I think learning from a programmed textbook is easy.....					
41. I disliked using a programmed textbook at first but now I like using it.....					
42. I think I learn more slowly from a programmed textbook than when the teacher explains the subject to me.....					
43. I think I learn less from a programmed textbook.....					
44. I think I would learn better if I did not have to write down the answers to any of the frames in a programmed textbook.....					
45. I think I learn more quickly from a programmed textbook than when the teacher explains the subject to me.....					
46. I think a programmed textbook is more interesting than a regular textbook.....					
47. I think I learn more quickly from a programmed textbook than from a regular textbook.....					
48. I think that a programmed textbook should be worked on <u>only</u> during class time.....					
49. I think learning from a programmed textbook is hard.....					

ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
50. I think I learn more slowly from a programmed textbook than from a regular textbook.....					
51. I think learning from a programmed textbook is not too easy or too hard, but just right.....					
52. I dislike using a programmed textbook more than when the teacher explains the subject to me.....					
53. I have more confidence in my ability to learn from a programmed textbook than from a regular textbook.....					
54. I think using a mask to cover up the answers in a programmed textbook helps me to learn.....					
55. I think I forget more of what I learn from a programmed textbook than from a regular textbook.....					
56. I have less confidence in my ability to learn from a programmed textbook than from a regular textbook.....					
57. I prefer working on a programmed textbook for only part of a period every day.....					
58. I think that I learn best when a programmed textbook and instruction by the teacher are combined.					

ATTITUDE QUESTIONNAIRE (continued)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
59. I think I forget more of what I learn from a programmed textbook.....					
60. I think that a programmed textbook is boring.....					
61. I think that a programmed textbook should be worked on only outside of the classroom.....					
62. I liked using a programmed textbook at first but I soon got tired of it.....					
63. I prefer to decide for myself how far I should work on a programmed textbook.....					
64. I have trouble keeping my mind on my work when I am using a programmed textbook.....					
65. I think that other kinds of activities in addition to a programmed textbook should be used in the classroom.....					
66. I think that learning from a programmed textbook is harder than learning from a regular textbook.					
67. My desire to learn grows as I work through a programmed textbook.....					
68. I think using a programmed textbook is more interesting than when the teacher explains the subject to me.....					

Appendix F

Summary of All Scores of All Subjects by Treatment Groups

NOTE: On the tables in Appendix F, the key to variable identification is as follows:

Variable Name	Variable No.
CREATIVITY MEASURES	
Circles, Fluency	1
" , Flexibility	2
" , Originality	3
" , Elaboration	4
" , Total	5
Improvements, Fluency	6
" , Flexibility	7
" , Originality	8
" , Elaboration	9
" , Total	10
Tin Cans, Fluency	11
" , Flexibility	12
" , Originality	13
" , Elaboration	14
" , Total	15
Consequences 1, Fluency	16
" , Originality	17
" , Total	18
Consequences 2, Fluency	19
" , Originality	20
" , Total	21

Variable Name	Variable No.
LEARNING ABILITY MEASURES	
Grade Average, All subjects (One decimal place)	22
" " , Science (One decimal place)	23
Gates Reading, Speed	24
" " , Vocabulary	25
" " , Comprehension	26
" " , Total	27
Lorge-Thorndike, Verbal Raw Score	28
" " , Verbal I.Q.	29
" " , Nonverbal Raw Score	30
" " , Nonverbal I.Q.	31
CRITERION TEST RAW SCORES	
Pre-test	32
Post-test 1	33
Post-test 2	34
ACHIEVEMENT MEASURES	
1st semester (Post-test 1 - Pre-test + 12)	35
Year (Post-test 2 - Pre-test + 10)	36
2nd semester (Post-test 2 - Post-test 1 + 28)	37
PERFORMANCE MEASURES (NUMBER OF CORRECT FRAMES)	
1st semester	38
2nd semester	39
Year (1st semester + 2nd semester)	40

GROUP I

VARIABLE NUMBER

S NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
101	16	15	16	15	62	5	3	3	0	11	4	3	0	1	8	1	0	1	2	0	2
102	20	16	10	6	52	11	6	9	0	26	5	3	3	0	11	3	3	6	1	0	1
103	9	3	0	11	23	7	2	6	2	17	4	3	5	1	13	4	4	8	2	1	3
104	15	15	18	33	81	3	3	0	0	6	5	5	4	2	12	2	1	3	3	2	5
105	9	6	2	17	34	15	5	13	4	37	5	4	5	2	16	3	4	7	2	2	4
106	25	19	17	12	73	14	3	9	0	26	5	4	2	1	12	4	6	10	3	2	5
107	5	4	2	6	17	5	4	0	1	10	2	2	4	0	8	1	1	2	1	0	1
108	12	8	12	49	81	7	6	4	2	19	5	3	3	0	11	5	3	8	3	2	5
109	9	8	1	14	32	5	3	4	2	14	2	3	1	2	8	0	0	0	1	0	1
110	18	15	14	35	82	16	6	9	0	31	12	8	10	1	31	3	5	8	3	3	6
111	5	5	0	13	23	10	6	9	0	25	2	2	2	0	6	1	0	1	1	3	4
112	9	5	8	32	54	9	2	6	0	17	7	5	7	0	19	1	5	6	1	3	4
113	13	11	5	22	51	24	9	21	0	54	9	7	4	0	20	4	8	12	3	4	7
114	6	5	5	23	39	5	2	4	0	11	7	6	10	0	23	3	4	7	3	2	5
115	11	9	1	19	40	15	6	10	0	31	5	4	8	0	17	2	3	5	4	3	7

GROUP I

VARIABLE NUMBER

S NO.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
101	31	30	26	41	30	81	52	105	46	102	23	83	86	72	73	31	3531	3423	6954
102	19	15	19	30	29	76	36	92	23	80	19	43	57	36	43	42	3372	3086	6458
103	20	20	13	36	33	82	39	99	48	105	53	90	82	49	39	20	3537	3440	6977
104	27	25	21	39	29	77	49	106	42	100	41	70	82	41	51	40	3378	3453	6831
105	40	40	24	49	37	92	61	114	64	128	63	121	129	70	76	26	3364	3308	6672
106	36	30	26	41	37	84	50	106	64	130	60	93	112	45	62	47	3317	3328	6645
107	22	20	16	33	28	71	40	98	50	110	19	53	72	46	63	47	3042	3184	6226
108	33	30	23	55	38	93	68	126	53	114	45	72	96	39	61	52	3429	3340	6769
109	23	25	16	34	23	68	38	93	35	91	50	38	53	0	13	43	3229	3425	6654
110	21	20	21	40	31	78	44	101	39	96	38	64	82	38	54	46	3340	3237	6577
111	35	35	20	39	33	79	60	116	55	116	60	73	91	25	41	46	3214	3195	6409
112	11	15	15	30	19	64	32	89	36	104	37	37	56	12	29	47	3380	3400	6780
113	33	35	22	28	26	68	48	102	51	109	46	64	71	30	35	35	3305	3233	6538
114	33	35	18	33	34	75	58	115	49	108	66	90	99	35	43	37	3127	3201	6328
115	23	25	18	35	29	74	42	100	43	101	49	73	73	36	34	28	3440	3378	6818

GROUP II

VARIABLE NUMBER

S NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
201	7	5	5	28	45	14	5	12	0	31	6	4	6	2	18	3	4	7	2	1	3
202	11	8	14	54	87	9	7	5	2	23	4	3	4	0	11	4	8	12	4	6	10
203	9	6	2	27	44	14	5	13	1	33	6	4	0	0	10	2	1	3	1	0	1
204	9	6	6	30	51	4	3	0	0	7	9	2	2	0	13	2	4	6	4	1	5
205	16	13	11	36	76	14	8	5	0	27	13	3	1	0	17	3	2	5	3	3	6
206	6	4	7	34	51	6	3	5	0	14	9	8	12	0	29	1	1	2	1	0	1
207	21	17	16	27	81	13	4	11	1	29	2	2	2	1	7	3	4	87	2	1	3
208	19	6	6	43	74	16	7	13	2	38	11	5	6	2	24	3	3	6	1	2	3
209	16	10	14	46	86	6	3	3	0	12	6	5	5	0	16	3	3	6	2	2	4
210	11	10	7	29	57	11	2	10	0	23	3	3	3	0	9	1	1	2	1	0	1
211	9	8	5	28	50	7	3	2	0	12	5	5	1	0	11	2	1	3	2	4	6
212	9	5	8	47	69	14	3	13	0	30	9	6	10	0	25	2	0	2	1	0	1
213	12	12	8	22	54	9	5	4	1	19	6	2	1	0	9	2	0	4	1	0	1
214	9	8	4	21	42	4	2	1	0	7	1	1	0	0	2	2	2	4	1	1	2
215	14	8	1	30	53	19	5	7	12	43	10	5	6	0	21	3	8	11	1	5	6
216	6	6	3	13	28	5	3	8	0	16	8	3	0	1	12	2	1	3	1	1	2
217	10	9	4	22	45	8	6	5	0	19	2	2	0	0	4	2	2	4	2	1	3
218	1	1	2	5	9	8	3	7	2	20	1	1	0	0	2	2	2	4	2	1	3
219	7	7	6	14	34	7	5	3	0	15	7	5	7	1	20	4	4	8	3	3	6
220	11	7	11	37	66	11	6	9	0	26	2	2	3	1	8	3	1	4	1	0	1
221	11	8	13	34	66	7	5	13	9	34	9	5	12	0	26	2	2	4	1	3	4
222	9	9	2	13	33	9	5	4	0	18	3	3	0	0	6	2	1	3	1	4	5
223	12	9	9	24	54	12	5	11	1	29	10	8	11	1	30	3	4	7	3	3	6
224	9	7	7	41	64	11	4	11	0	26	6	6	5	0	17	5	4	9	3	3	6
225	14	11	7	34	66	10	3	5	2	20	2	2	0	0	4	3	3	6	2	0	2

GROUP II

VARIABLE NUMBER

S NO.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
201	32	40	28	34	34	77	69	123	61	123	65	92	106	39	21	42	3428	3375	6803
202	31	35	24	46	29	85	60	113	47	103	61	90	96	41	45	34	3136	3278	6414
203	24	25	18	44	33	83	50	107	48	107	35	68	73	45	48	33	3140	3107	6247
204	32	35	21	43	33	85	54	108	59	121	56	84	101	40	51	45	3313	3263	6576
205	18	15	17	24	22	60	46	95	41	117	43	61	53	30	20	20	3123	3177	6300
206	17	20	14	34	27	83	50	103	50	107	40	59	66	31	36	35	3251	2233	5484
207	23	20	19	33	31	74	47	101	49	106	49	72	74	35	35	30	3223	3301	6524
208	26	30	20	38	34	82	52	105	57	117	52	72	81	32	39	37	3366	3430	6796
209	21	20	12	26	23	87	32	90	46	105	31	53	63	34	42	38	3301	3348	6649
210	25	25	15	23	29	76	38	97	47	107	32	68	73	48	21	33	2775	2816	5591
211	40	40	28	47	37	88	62	118	64	130	49	98	122	61	83	52	3464	3450	6914
212	24	25	20	36	32	74	50	107	53	114	43	53	55	22	22	30	3556	3450	7006
213	33	30	21	34	36	76	60	113	49	105	59	65	88	18	39	51	3425	3305	6730
214	35	35	19	49	39	94	68	125	61	125	64	86	104	34	50	46	3470	3402	6872
215	19	20	17	45	23	94	44	102	44	102	33	59	39	38	16	8	2654	2895	5549
216	20	20	14	24	28	65	34	85	19	71	36	48	46	24	20	26	2430	2889	5319
217	26	25	21	36	28	75	42	97	42	98	42	69	72	39	40	31	3421	3412	6833
218	28	35	19	41	36	92	74	137	47	107	64	105	104	53	50	27	3300	3274	6574
219	24	30	15	32	36	85	45	101	64	130	40	87	106	59	76	47	3091	3171	6262
220	23	30	11	22	27	74	39	94	50	108	34	84	116	62	92	60	3110	2976	6086
221	37	40	15	52	32	90	61	114	56	115	82	107	124	37	52	45	3322	3308	6630
222	23	30	16	34	26	71	42	99	50	109	36	89	99	65	73	38	3529	3466	6995
223	39	40	20	48	36	86	70	125	58	118	45	71	96	38	61	53	3302	3270	6572
224	33	30	19	30	37	75	48	102	55	115	36	67	84	43	58	45	3069	3107	6176
225	29	25	26	34	36	78	37	93	51	109	46	68	70	34	34	30	3438	3401	6839

GROUP III

S NO.	VARIABLE NUMBER																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
301	14	5	6	32	57	10	7	7	0	24	5	2	0	3	10	4	3	7	2	2	4
302	6	5	4	16	31	10	3	6	1	20	5	5	4	1	15	2	1	3	1	2	3
303	14	12	3	26	55	10	4	5	4	23	3	2	0	4	9	3	4	7	2	3	5
304	27	21	19	51	118	12	6	8	2	28	6	4	4	1	15	4	5	9	3	5	8
305	22	18	17	60	117	18	9	13	0	40	26	12	23	2	53	6	9	15	3	1	4
306	31	10	25	91	157	12	5	4	2	23	7	6	4	0	17	1	3	4	2	1	3
307	19	13	13	35	80	8	4	3	0	15	4	1	0	0	5	2	1	3	2	4	6
308	10	9	12	38	69	14	4	9	0	27	6	4	7	1	18	3	5	8	2	3	5
309	20	15	10	44	89	18	8	19	2	47	8	3	1	4	16	3	5	8	3	2	5
310	20	12	14	21	67	17	5	16	0	38	14	8	13	0	35	2	2	4	1	0	1
311	5	5	3	19	32	10	5	6	0	21	3	3	2	5	13	3	3	6	1	2	3
312	17	7	4	39	61	8	5	6	2	21	7	5	10	0	22	0	0	0	1	0	1
313	9	7	3	32	51	10	4	11	0	25	7	2	6		15	3	2	5	2	0	2
314	11	7	4	33	55	8	7	4	4	23	1	1	0		9	3	4	7	2	2	4
315	11	7	7	20	45	14	6	14	0	34	6	4	4	0	14	2	3	5	2	0	2
317	12	9	5	27	53	12	5	6	1	24	7	6	2	1	16	2	0	2	2	3	5

GROUP III

VARIABLE NUMBER

S NO.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
301	15	10	14	31	24	67	41	99	51	111	26	44	33	30	17	17	3160	2834	5994
302	22	20	13	18	13	45	45	96	41	97	34	54	31	32	7	5	2977	3110	6087
303	35	30	30	49	37	89	69	126	61	125	68	101	115	45	57	42	3434	3374	6808
304	37	35	24	41	31	80	50	107	45	104	68	92	106	36	48	42	3457	3387	6844
305	28	30	21	28	31	71	63	119	62	127	36	60	64	36	38	32	3505	3401	6906
306	28	25	23	32	31	76	48	104	38	95	50	54	80	16	40	54	3290	3125	6415
307	25	25	12	27	23	62	35	86	25	79	47	55	59	20	22	32	2690	2638	5328
308	37	35	24	43	35	88	61	117	63	129	48	88	96	52	58	36	3527	3443	6970
309	40	40	27	39	36	82	59	112	60	122	43	79	87	48	54	36	3538	3440	6978
310	16	15	18	27	18	62	32	88	47	104	33	45	104	24	81	87	3275	3372	6647
311	40	40	28	54	38	98	71	130	61	126	52	99	110	59	68	39	3442	3328	6770
312	11	10	11	16	11	60	23	76	25	80	24	27	39	15	25	40	2074	2617	4691
313	24	20	29	45	34	86	63	119	50	109	50	83	95	45	55	40	3443	3415	6858
314	22	20	24	16	32	80	51	108	27	121	57	82	97	37	50	43	3402	3371	6773
315	28	30	20	40	36	82	47	100	50	107	32	97	88	77	66	19	3299	3323	6622
317	16	20	15	27	28	66	39	97	38	96	37	67	83	42	56	44	2936	2963	5899

GROUP IV

VARIABLE NUMBER

S NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
401	14	14	8	24	60	13	6	10	1	30	5	3	8	6	22	3	3	6	1	0	1
404	25	8	9	10	52	18	6	14	1	39	5	4	9	0	18	2	0	2	1	2	3
405	8	7	1	16	32	13	4	11	0	28	6	5	6	0	17	1	4	5	4	6	10
406	10	9	11	16	46	10	5	9	4	28	4	3	4	2	13	3	3	6	2	1	3
407	16	15	7	15	53	15	7	9	0	31	8	4	6	0	18	3	1	4	3	3	6
408	21	17	15	27	80	18	6	25	0	49	11	6	19	0	36	4	5	9	4	8	12
409	5	5	4	7	21	10	2	11	6	29	5	4	6	2	17	2	3	5	3	3	6
410	14	13	19	12	58	13	5	12	7	37	7	4	3	7	21	4	5	9	3	1	4
411	9	8	3	9	29	10	3	8	0	21	4	4	8	1	17	2	2	1	1	2	3
412	15	13	12	16	56	9	4	5	0	18	5	3	0	0	8	3	2	5	1	1	2
413	9	8	6	8	31	8	2	5	0	15	8	4	2	7	21	3	3	6	4	1	5
414	15	13	12	16	56	8	4	5	1	18	5	3	0	1	9	2	3	5	1	0	1
415	1	1	0	2	4	13	6	12	2	33	7	5	4	0	16	3	3	6	1	3	4
416	14	13	9	19	55	6	5	2	0	13	4	3	6	0	13	4	4	8	2	0	2
418	9	9	2	9	29	5	3	3	1	12	5	5	3	1	14	3	5	8	1	1	2
419	11	8	3	5	27	16	6	20	0	42	7	6	3	0	16	3	4	7	5	3	8
420	12	9	1	12	34	11	4	7	1	23	11	6	16	0	33	3	4	7	2	2	1
422	13	12	7	8	40	10	3	9	0	22	6	4	4	1	15	4	2	6	2	1	3

GROUP IV

S NO.	VARIABLE NUMBER 22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
401	31	30	19	30	33	74	51	107	49	107	49	72	87	35	48	43	3551	3408	6959
404	18	15	20	23	21	60	36	93	48	106	40	52	57	24	27	33	3095	3300	6395
405	24	20	24	38	27	76	42	100	52	112	24	61	71	49	57	38	3293	3432	6725
406	40	40	23	50	41	92	69	129	65	134	67	106	125	51	68	47	3450	3400	6850
407	23	25	13	26	32	68	43	97	55	114	30	46	57	28	37	39	3275	3418	6693
408	39	40	30	54	39	94	80	139	61	121	79	102	113	35	44	39	3423	2926	6349
409	23	30	27	44	34	90	59	115	53	113	64	89	63	37	9	2	3269	3287	6556
410	36	40	30	53	41	94	66	123	45	103	61	92	100	43	49	36	3360	3387	6747
411	8	5	10	9	0	27	25	77	36	89	37	36	36	11	9	28	2151	2819	4970
412	34	25	23	43	32	84	60	114	51	109	60	88	91	40	41	31	3453	3454	6907
413	33	30	25	39	27	77	59	113	49	106	49	56	74	19	35	46	3281	3392	6673
414	39	35	27	48	32	84	60	116	52	111	58	70	78	24	30	36	3470	3408	6878
415	28	25	18	34	31	74	52	106	49	106	51	77	87	38	46	38	3532	3447	6979
416	26	25	18	39	19	62	57	110	53	111	42	57	49	27	17	20	3365	3432	6797
418	22	15	23	34	29	73	37	89	46	99	42	52	71	22	39	47	3192	3329	6521
419	28	20	20	43	33	83	54	104	47	101	45	71	86	28	51	43	3462	2692	6154
420	10	10	13	31	26	73	35	93	47	106	50	62	65	24	25	31	2751	3041	5792
422	24	20	20	34	31	75	45	102	49	108	43	73	82	42	49	37	3131	3334	6465